APPENDIX B
Environmental Evaluation

ENVIRONMENTAL EVALUATION

SAN JOAQUIN RIVER MAINSTEM AND TRIBUTARIES

RECONNAISSANCE STUDY

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ATTACHMENTS

INTRODUCTION

Background and Authorization. The Corps of Engineers, Sacramento District, is conducting a reconnaissance study of flood control and environmental restoration alternatives for the San Joaquin River Mainstem and Tributaries, California. The purpose of this reconnaissance study, authorized by the 1964 Congressional Resolution of the House Committee on Public Works, is to determine the potential for Federal participation in the development and construction of flood control and/or environmental measures within the San Joaquin River Basin.

The authority to study environmental restoration comes from Section 1135(a) of the Water Resources Development Act (WRDA) of 1986 as amended by Section 41 of the WRDA of 1988 and Section 304 of the WRDA of 1990. Additional guidance is contained in Policy Guidance Letter No. 24, "Restoration of Fish and Wildlife Resources," March 7, 1991.

Study Area and Scope of Analysis. The study area includes the San Joaquin River from Friant Dam downstream to Stockton, a distance of 225 river miles, and all major tributaries up to the first flood control dam (Figure 1). The area also includes the North Fork of the Kings River from the southern boundary of the James Reclamation District Number 1606 to Mendota Dam. However, because of various constraints, this study has focused primarily on the mainstem of the San Joaquin River, making the San Joaquin Valley floor the effective study area.

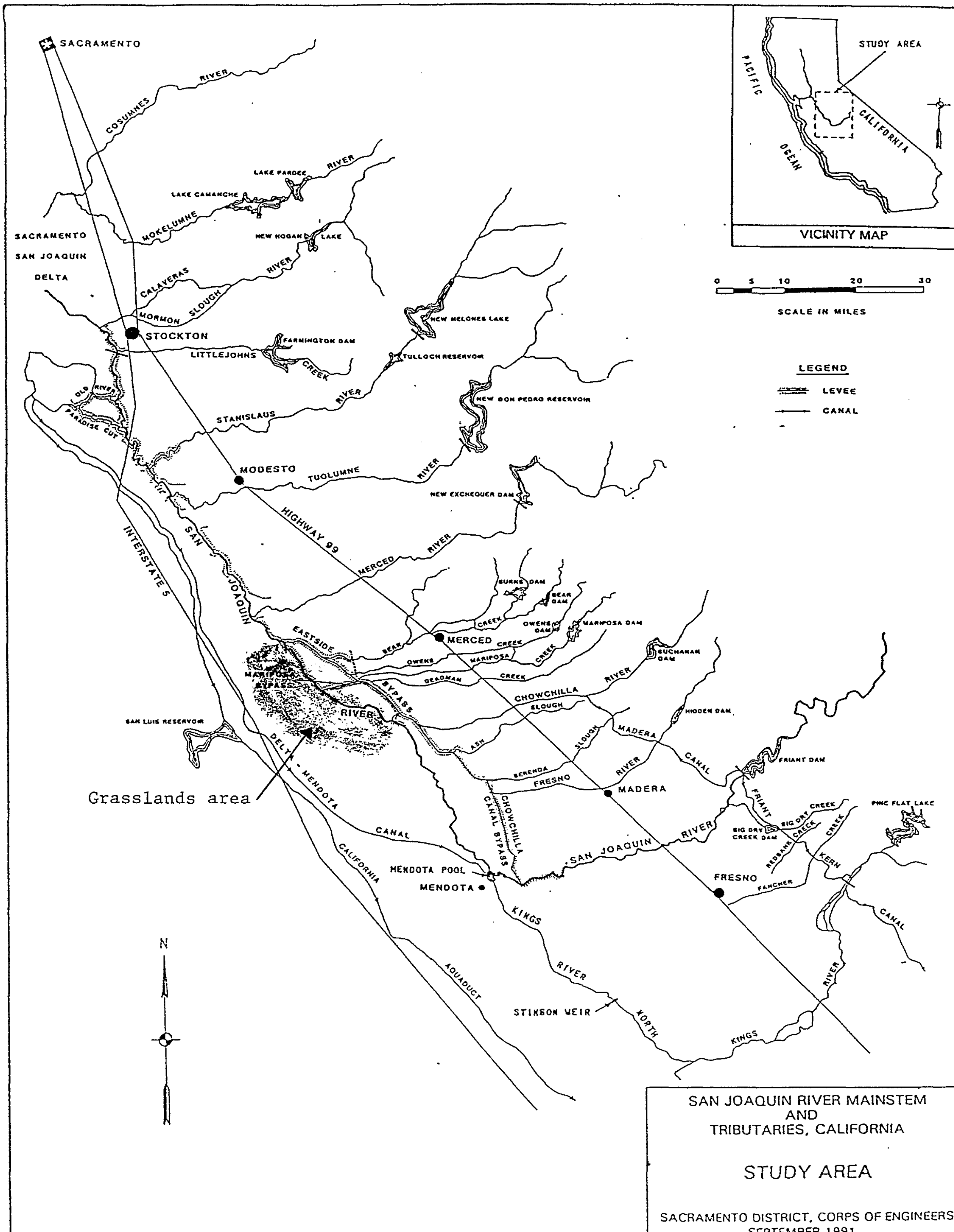
The study area is within the San Joaquin River basin which covers approximately 14,000 square miles in Central California. The San Joaquin River traverses the eastern side of the basin, extending from glacial lakes in the Sierra Nevada to its mouth in the Delta. Major tributaries are the Stanislaus, Tuolumne, Merced, Chowchilla, and Fresno Rivers. Portions of the counties of Fresno, Madera, Merced, Stanislaus, and San Joaquin are within the study area.

This environmental evaluation will serve as a baseline for subsequent planning efforts and impact assessments and outlines the problems, needs, and opportunities of the study area and possible solutions. The environmental setting and potential impacts to key resources such as vegetation, wildlife, and water quality are discussed.

Problems, Needs, and Opportunities. The study area is experiencing major hydrological and environmental problems. In addition, adequate recreational opportunities are lacking. These are discussed below.

Hydrological Problems. Historically, flooding has been a major problem in the basin. Floods often occur during late fall

FIGURE 1



Grasslands area

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and winter, primarily as a result of prolonged general rainstorms, and during the spring and early summer, primarily as a result of unseasonable and rapid melting of the winter snowpack in the Sierra Nevada. Fed by many hundreds of streams, the main channel of the San Joaquin River and its tributaries has historically overtopped their banks. Flood control projects have not eliminated this threat.

Another problem is active river bank erosion throughout the entire San Joaquin basin. Most of the erosion is due to the meandering nature of the river system. Tight river bends, high vertical banks, and seasonal fluctuations in channel flows contribute to the erosion. Most of the worst erosion occurs on the outside of bends; erosion is less serious on straight sections and on the inside banks of the meanders.

Throughout the San Joaquin River system, aggradation, erosion, and agricultural practices have caused large amounts of sediment to accumulate in the San Joaquin River. This sediment has reduced the flow capacity of the channel and increased the frequency and duration of high water stages. In San Joaquin and Stanislaus Counties, these high stages in the river channel have caused numerous levee failures and seepage problems at flows substantially below the design capacities. Bank erosion, low turbid flows during dry years, and agricultural runoff are the primary sources of this sediment buildup on the mainstem of the San Joaquin River. The overall effect of the ongoing sediment deposition is a reduction in the amount of flood protection for the San Joaquin basin.

Recreational Problems. The single largest problem affecting recreation on the mainstem and tributaries of the San Joaquin River is the significant lack of water in many reaches. As the water supply and water quality of the rivers decrease, so do the supply and quality of experiences for fishing, swimming, and boating. These limitations imposed by water constraints only add to the unusually limited recreational opportunities and variety of activities along approximately 225 miles of river habitat. The lack of managed access, and the lack of managed fishing sites, must also be mentioned in any discussion of problems on the San Joaquin River system.

The need for outdoor recreation areas is well-documented at national, State and local levels. The five counties that comprise the study area had a 1990 population of 1.78 million people, and this number is expected to double in approximately 40 years. To meet the current unmet and future needs of the San Joaquin River area, all efforts must be explored and implemented to create a variety of recreational and leisure opportunities.

Environmental Problems. The San Joaquin Valley was historically a diverse and productive natural environment. The valley floor was a complex network of oxbows, sloughs, creeks, rivers, lakes, ponds, a mosaic of natural wetlands (permanent and seasonal), and upland habitats. Large populations of fish and wildlife existed. Historical accounts from early expeditions and pioneers described huge herds of pronghorn antelope, tule elk, and mule deer grazing the prairies, large flocks of waterfowl in the extensive wetlands, and enormous numbers of fish in the many waterways. Such rich biological diversity and productivity supported the densest nonagricultural population of Native Americans in North America (SJVDP, 1990).

Large-scale alteration of the natural communities of the San Joaquin River Valley occurred with the advent of the California gold rush. Mining activities altered streambanks and streamflows, and natural areas were converted to agricultural use to produce food for the mining communities. When mining declined in the late 1800's, large-scale agriculture began and extensive wildlands were converted to croplands. In addition, massive water diversions for agricultural uses depleted streamflows and adversely affected natural communities in and along the San Joaquin River and tributaries.

Conversion of wildlands to intensive agricultural use has continued throughout the 20th century. In recent years urban growth has spiraled and is now threatening both remaining essential wildlife habitats and beneficial agricultural lands.

Specific problems are summarized in the following paragraphs.

<u>Loss of Riparian Habitat and Wetlands</u>. For this report, riparian habitat refers to those areas of typically woody vegetation, usually located adjacent to rivers, streams, lakes and ponds, which are dependent on high soil moisture and/or periodic flooding. Wetlands refers to those non-riparian areas permanently or seasonally inundated by shallow water. This includes both permanent and seasonal wetlands such as tule marshes, wet meadows, and vernal pools.

Under pre-European settlement conditions, over 900,000 acres of riparian forest and woodland existed in the San Joaquin Valley (San Joaquin Valley Drainage Program [SJVDP], 1990). It is now estimated that the historic extent of riparian habitat in the San Joaquin Valley has been reduced by approximately 96 percent. In addition, at least half of the remaining riparian vegetation is disturbed or degraded. Although efforts are being taken to reduce losses and restore the condition of existing riparian habitat, the decline in habitat quality and diversity continues.

Historically the Central Valley of California contained more than 4 million acres of wetlands which supported untold millions of waterfowl and shorebirds as well as other wildlife. As of

1989, only 281,000 acres of wetlands remained, a loss of more than 90 percent (Frayer, et.al., 1989). Data compiled by the U.S. Fish and Wildlife Service (FWS) for the Grasslands/Los Banos area in the mid-San Joaquin Valley show a loss of over 133,000 wetland acres from 1939 to the mid-1980s. This represents a loss of about 61 percent of the estimated pre-1939 wetland acreage for this particular area. In addition, many remaining wetland areas do not receive good quality water consistently enough to operate at their peak habitat value. Although efforts to reduce and/or eliminate wetland losses are being taken, the present trend is for the continued decline of wetlands.

The Central Valley of California, including the San Joaquin Basin, is the most important wintering area for waterfowl in the Pacific Flyway, currently supporting 60 percent of the total population (Central Valley Habitat Joint Venture Implementation Plan, 1990). Central Valley wetlands are therefore vital for maintaining waterfowl populations of the Pacific Flyway.

Loss of Native Fisheries. Historically the San Joaquin River system contained a productive fishery. Native anadromous species were abundant in regular intervals and included steelhead, sturgeon, and at least two races of chinook salmon (spring and fall). The spring-run chinook salmon was the most numerous of the species, exceeding 200,000 returning adults in peak years (SJRDP, 1990). However, native freshwater communities have largely been replaced by introduced species, and their existence is threatened. Native anadromous species occur in reduced and dramatically fluctuating numbers. The spring-run salmon is extinct. The fall-run race remains in low numbers and is restricted to tributaries above the mainstem and Salt Slough. Overall, chinook salmon production in the San Joaquin River drainage has declined by over 85 percent since the 1940's (SJRDP, 1990).

Decline of Wildlife Populations (Biodiversity). Compared to historical accounts, the San Joaquin Valley has experienced a marked decline in both wildlife species and populations. Gone are the grizzly bear and free-ranging herds of antelope and elk. Many others are severely reduced to remnant levels. The FWS has over 60 species listed as endangered, threatened, or candidates. The reduction in wildlife populations and species diversity is often a direct result of habitat loss (particularly riparian areas and wetlands), degradation, and fragmentation. In the San Joaquin Valley, fragmentation has been especially hard on wildlife populations and species diversity by turning habitat areas into isolated patches or islands surrounded by agricultural and urban development. This restriction and isolation of wildlife populations threatens the continued viability of these populations and, in some cases, the species' existence. The future trend for the San Joaquin Valley is the continued loss of native species and natural wildlife communities and an increase in threatened and endangered species and numbers of non-native species, especially those adapted to degraded areas and human disturbance.

Habitat loss, degradation, and fragmentation adversely affect wildlife populations and species genetically and demographically. Genetic impacts occur from inbreeding depression and subsequent lower genetic diversity in offspring. This results from populations being reduced in numbers and forced into closed, isolated conditions and leads to a population unable to adapt to changing environmental conditions. Demographic impacts have occurred in four ways: increased mortality due to presence of high risk conditions (i.e., roads and highways, urban development, exotic species); suppression of wide ranging, low density species (usually top level predators) through elimination of large parcels of habitat necessary for breeding and feeding and home ranges; discrimination against migratory wildlife species due to lack of continuity of riparian vegetation and, thus, migration corridors; and increased vulnerability of small, isolated populations to random, often catastrophic, events such as disease, flooding, and fire (SJRMP, 1992).

<u>Contaminated Irrigation Water and Inadequate Drainage</u>. High concentrations of contaminants whose source is irrigation drainage water have been discovered in water, sediments, food-chain organisms, and major vertebrates in a number of areas in the San Joaquin Basin. Many basin rivers, streams, ponds, riparian habitats, and wetlands, all important fish and wildlife habitat, have been affected. In many locations concentrations of contaminants have exceeded established toxicity thresholds. In some cases biomagnification through food chains has increased the magnitude of some drainage contaminants. Numerous studies have documented adverse biological effects that are due to contaminants carried by irrigation drainage water. The potentially toxic contaminants of most concern in the basin are selenium and boron. When these trace elements become concentrated, plant and animal growth and health suffer. Highly saline water is also a health threat to wildlife and a big concern in the basin.

Poor or inadequate drainage of many agricultural lands is a chronic and extensive problem in the basin. Inadequate drainage affects over 2 million acres of farmland in the basin (SJRDP, 1990). Much of this area is located on the west side and southern end of the valley where a combination of natural and anthropogenic actions have created a formula for acute drainage problems. These actions include geologic deposition of salts and trace elements in the soil; movement and concentration of dissolved substances in valley soils and water from the Coast Range; importation and application of vast quantities of irrigation water; and of subsurface clay layers under valley soils which impedes the vertical movement of water.

Drainage problems inevitably lead to a salt buildup in the soil. Over time salt becomes concentrated in the root zone of plants and the soil surface. When this occurs, plant growth is adversely affected and crop yields decline. Eventually the land may go out of production.

Finally, there is a problem getting the drainage water out of the basin. Currently much of the drainage water is held in evaporation ponds or conveyed into sloughs and rivers. There the contaminated water affects the biological resources of the basin as described earlier. Concentrations of salts and trace elements will continue to increase in basin soils and waters unless drainage water can be exported out of the basin.

Major Causes of Environmental Problems

Water Development Projects. Local, State, and Federal flood control and water development projects account for the major losses of wetlands and riparian habitat in the Central Valley (Frayer, et.al., 1989). Most of the lost wetland and riparian acreage is due to conversion to agricultural use. Flood control and water storage and diversion projects have led to this conversion by reducing or eliminating streamflows and changing water tables (lower in some areas, higher in others). This has resulted in losses of woody riparian habitat and wetlands and subsequent shifts in biological communities from historic conditions. Effects of water diversion are further discussed under Agricultural Operations.

Flood control along the mainstem has caused direct impacts on riparian and wetland wildlife habitat areas through construction of levees and bypasses and removal of sediment and vegetation. These activities have destroyed streamside vegetation, denied floodwaters to wetlands and riparian areas, and filled in many acres of wetlands. Fish and wildlife decline in numbers as these habitat areas diminish or are adversely affected.

Indirect impacts on riparian and wetland wildlife habitat areas have resulted from the numerous upstream multipurpose water storage projects in the basin which have changed the river's hydrology and flood plain. Reduced peak flows have lowered the water table and narrowed the 100-year flood plain. This has allowed and/or encouraged the development (primarily agricultural) on these historic riparian and wetland areas, largely eliminating their wildlife habitat values. Thus, fish and wildlife resources are further diminished.

Native fish, especially anadromous species, have also been directly affected by water development projects. Upstream impoundments have altered the hydrology of the river system and eliminated spawning areas, while channel clearing and levee construction have reduced fish habitat in the mainstem, especially important shaded riverine aquatic habitat. Dams on the mainstem and tributaries have blocked access to approximately 40 percent of upstream spawning and rearing areas. Dams have also caused a loss of gravel recruitment and gravel cleansing flows to downstream reaches.

The direct and indirect impacts from these local, State, and Federal projects have caused a serious decline in the biological resources of the San Joaquin Valley. Although the cumulative impact of all the various projects cannot be overlooked in assessing responsibility for the current poor condition of the valley's fish, wildlife, and habitats, individual projects and the agencies that planned and built them bear a large part of the responsibility.

Agricultural Operations. Current agricultural operations adversely affect fish, riparian habitats, and wetlands primarily through water diversions from the river system and input of contaminated drainage water which seriously degrades water quality and biological communities.

Water diversions for irrigation withdraw large quantities of river water, effectively dewatering stretches of the mainstem. In most years during the irrigation season, there is low to no surface flow between Friant Dam and Mendota Pool, and no flows in portions of the mainstem between Mendota Pool and the Merced River. Where surface flows are present, they are so low that temperatures are often too high for many native fish species. Furthermore, changes in streamflow regimes, particularly the storing of high spring and summer flows in upstream impoundments, have adversely affected adult fish immigration and juvenile fish emigration. Reducing instream flows during the critical downstream migration period has been especially damaging to salmonids. In short, instream flows in the mainstem San Joaquin River and many of its major tributaries are inadequate to sustain healthy native fisheries.

Contaminated drainage water results from large-scale irrigation of basin farmlands. As explained earlier, many lands, particularly along the west side, have naturally high levels of salt and various trace elements such as boron and selenium. For example, almost 200,000 acres in the San Joaquin Basin have soils with boron concentrations greater than 2 ppm (SJRDP, 1990). The massive application of vast quantities of irrigation water both builds up and leaches salts and trace elements in and from the soil and tends to concentrate them in areas that receive the drainage water. This includes surface waters, ground water, and soils through evaporation. Plants and animals that use these areas assimilate the contaminants and suffer the effects from chronic exposure.

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Need and Justification for Environmental Restoration. The need for environmental restoration in the San Joaquin Valley is based primarily on the value of riparian and wetland areas and their now limited extent. The numerous Corps projects and flood control operations in the San Joaquin Basin which have contributed to environmental problems justify Corps involvement and provide a Federal interest in environmental restoration. This is strengthened by the fact that several State and Federal agencies are actively pursuing restoration of riparian and wetland areas in the basin. The Corps of Engineers is committed to the goal of responsibly protecting and restoring the environment.

<u>Value of Riparian and Wetland Areas</u>. With high diversity (structural and species), dense cover, high plant productivity, and ample availability of water, riparian areas are likely the most important habitat for wildlife in the arid west. A great variety of wildlife, including many threatened and endangered species, depends on these areas. Songbirds, raptors (including the bald eagle and Swainson's hawk), various waterbirds, waterfowl, furbearers, and small mammals all use this habitat extensively for feeding, nesting, resting, and escape cover. Riparian zones provide critical movement and migration corridors for mammals, migratory birds, and other terrestrial wildlife species.

Many wildlife species depend exclusively upon the attributes provided only by riparian habitat and therefore do not occur anywhere else. Overall, about 25 percent of the native terrestrial mammal species, 50 percent of the reptile species, and 75 percent of the amphibians in California are dependent on riparian habitats (USFWS, 1989). In California, more species of birds are dependent on riparian habitats than any other habitat.

Not only is riparian vegetation highly productive for wildlife that use associated terrestrial communities, it also interacts with and serves important functions for the adjacent stream ecosystem. Trees and shrubs overhanging the water provide water temperature moderation and protective cover for juvenile anadromous and resident fish. Overhanging vegetation also supplies up to 90 percent of the nutrients taken in by instream aquatic organisms in the form of fallen leaves, branches, and invertebrates, providing a critical energy source for the stream ecosystem (USFWS, 1989). Riparian vegetation serves an important role in the life cycles of many aquatic insects, providing feeding, resting, and breeding areas during specific life stages.

Wetlands comprise one of the Earth's most productive natural systems. They have a remarkable ability to capture and store energy and nutrients. This makes wetlands valuable and desirable areas for many wildlife species. They provide vital resting, breeding, and feeding places for birds, both migratory (which fuel up at wetlands on their journeys) and resident species. This includes all types of waterfowl, wading birds, shorebirds, and others. Wetlands are essential for amphibians, fish, shellfish, and other species adapted to life in shallow water. Many of these wetland-adapted species are unique and specialized and, thus, rare. Wetland habitats are therefore necessary for the survival of a disproportionately high percentage of endangered and threatened species.

In addition to serving important ecological functions, riparian areas and wetlands provide a number of important hydrologic functions and social and economic values. These short- and long-term benefits have become increasingly recognized by agencies and individuals at the local, State, and national levels who are charged with the management of flood plains.

As part of the natural flood plain, riparian and wetland ecosystems function as water filters, helping to maintain and improve water quality. They also detain and gradually release floodwaters, thereby reducing floodflows and associated flood damages in downstream areas. They provide natural groundwater recharge basins, bank stabilization, and water pollution and erosion control.

Many communities have come to appreciate the social and economic benefits provided by riparian areas and wetlands. Local governments concerned with the long-term quality of life in their communities have recognized that preservation of riparian and wetland habitats provides highly desirable open space, recreation (including fishing, hiking, bird watching, photography, camping and hunting), esthetics, and outdoor education. Economic benefits include increased property values for land adjacent to these natural areas, increased water supply, and lower costs for stormwater management, flood protection, and water treatment.

<u>Summary of Corps Projects</u>. The Corps has constructed or funded the construction of many flood control and multipurpose storage projects in the San Joaquin River Basin. The Corps continues to operate most of these to provide flood control. Figure 1 shows the location of these onstream storage projects, listed below.

Constructed and Operated:

- Burns Dam
- Bear Dam
- Owens Dam
- Mariposa Dam
- Buchanan Dam and Eastman Lake
- Hidden Dam and Hensley Lake
- Pine Flat Dam and Lake
- New Melones Dam and Reservoir

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Funded (operated by others):
- Friant Dam and Millerton Lake
- New Don Pedro Dam and Reservoir
- New Exchequer Dam and Lake McClure

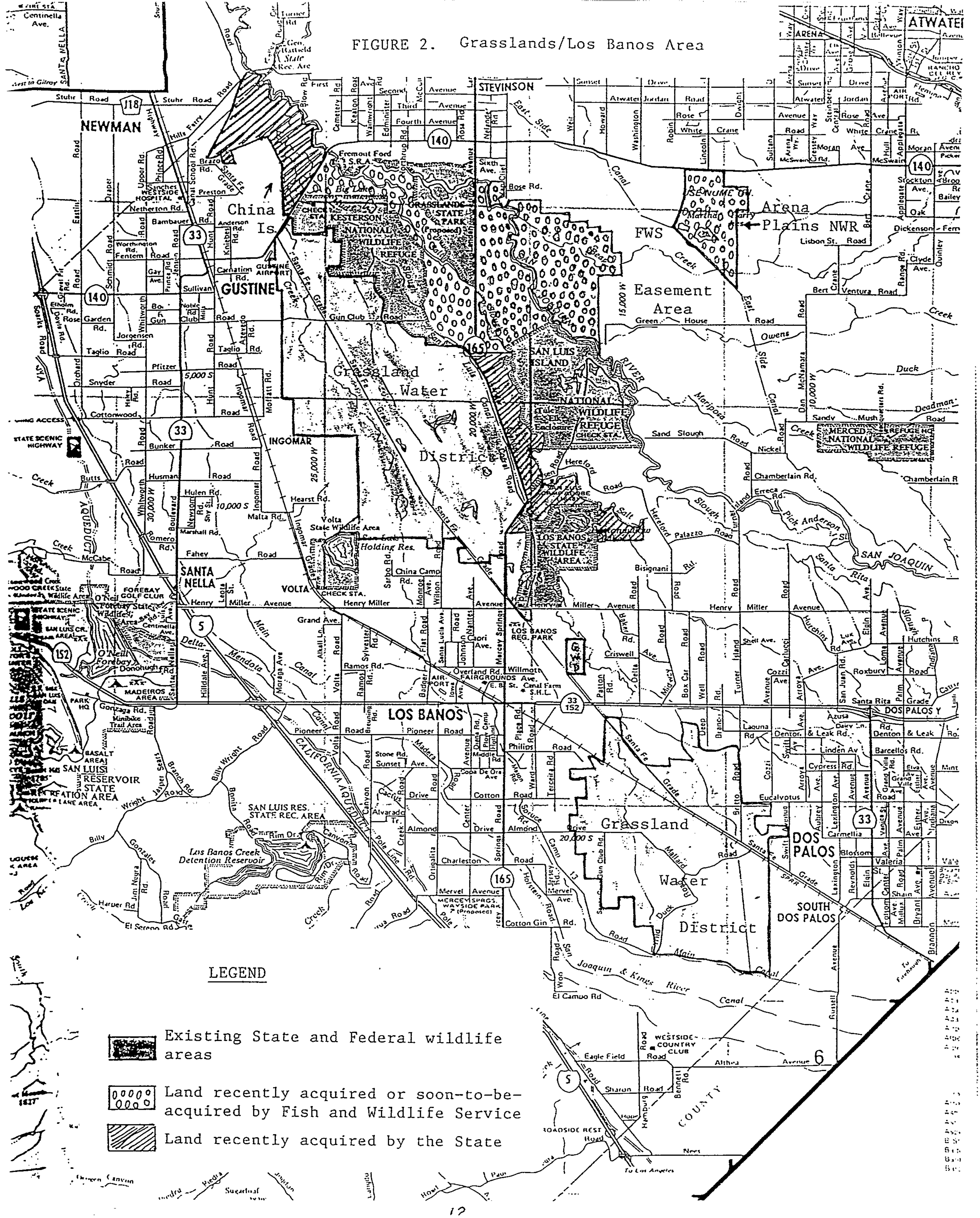
In addition to these projects, the Corps has completed flood control work along the mainstem San Joaquin River. Between 1956 and 1972, over 100 miles of levees were built along the mainstem from the Calaveras River to the Merced River. These levees extended a short distance up the Stanislaus, Tuolumne, Middle, and Old Rivers and Paradise Cut. The Corps also has undertaken actions to improve mainstem channel capacities. In 1968, 1969, and 1970 the Corps conducted channel clearing (vegetation removal) on the Upper San Joaquin from State Highway 41 to Gravelly Ford. Sediment has been removed from Middle River to the Merced River and at the upstream end of the State of California-built East Side Bypass.

Finally, the Corps has been active in flood control on Merced County streams. Levee construction, channel improvements, and diversion channels have been completed along the lower reaches of Bear, Burns, Mariposa, and Owens Creeks for both flood control and irrigation.

Environmental Restoration Opportunities. As indicated above, there is a strong Federal interest in environmental restoration within the San Joaquin River Basin. There are great opportunities as well. Several Federal agencies are participating in environmental programs and committing staff and funds toward meeting environmental goals and solving environmental problems. In addition, FWS and the California Department of Fish and Game (CDFG) have been acquiring marginal agricultural land in the flood plain in the Grasslands/Los Banos area and plan to devote it to wildlife habitat (Figure 2). Finally, the State of California Wildlife Conservation Board is beginning a statewide riparian restoration and protection program. Two other important programs are discussed below.

<u>Central Valley Habitat Joint Venture</u>. Environmental restoration projects embrace the objectives of the Central Valley Habitat Joint Venture (CVHJV) and the North American Waterfowl Management Plan (NAWMP). In 1986, the United States and Canadian governments, concerned over the decline in duck populations, developed and signed the NAWMP. This plan provides a broad framework for waterfowl conservation and management based on population and habitat goals needed to meet public demand.

FIGURE 2. Grasslands/Los Banos Area



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Implementation of the NAWMP is the responsibility of designated joint ventures, in which agencies and private organizations collectively pool their resources to solve waterfowl habitat problems. The California CVHJV was formally established by a working agreement in 1988. The primary goal of the joint venture is to protect, maintain, and restore habitat to increase waterfowl populations to desired levels in the Central Valley. The objectives for meeting this goal include habitat acquisition, securing water and power for wetland management, wetland restoration and enhancement, and enhancement of agricultural land.

In 1989, the Assistant Secretary of the Army signed a Cooperative Agreement with the Assistant Secretary of the Interior to use Corps projects to assist in the conservation, development, and management of habitat for waterfowl and other wetland species in response to goals set forth in the NAWMP.

The California CVHJV produced an implementation plan in 1990. The San Joaquin Basin is a high priority area within this plan. The plan's current wetland restoration goal for the San Joaquin Basin is 20,000 additional acres.

San Joaquin River Management Program. Environmental restoration projects also meet the objective of the San Joaquin River Management Program (SJRMP), a State of California program designed to address multi-resource problems, needs, and solutions for the San Joaquin River. The objective of the program is to identify actions which will benefit legitimate uses of the river system and to develop compatible solutions which meet water supply, water quality, flood protection, fisheries, wildlife, and recreational needs. Subcommittees were formed for each of these subject areas to formulate actions and tasks. The Wildlife Subcommittee has proposed riparian and wetland creation and restoration to benefit threatened and endangered species, waterfowl, raptors and other birds, mammals, and other animals and plants. The Corps of Engineers has endorsed this program and is an active participant in its operations at all levels.

Thus, opportunities for environmental restoration abound in the San Joaquin River Basin, particularly along the mainstem. The Corps could develop an environmental restoration project that would fit into and take advantage of any of the above programs. These programs represent good possibilities for interagency cooperation and cost-sharing on environmental restoration projects.

There is also a tremendous opportunity to tie together all environmental programs and goals with flood control desires. A comprehensive management plan could be developed for the San Joaquin River corridor that focuses on environmental restoration, but is sensitive to, and may include solutions to, flood control and agricultural problems. Having a comprehensive management plan for a project would avoid taking a piecemeal approach to the problems of the river system; instead, the system would be addressed as a whole. A comprehensive or overall project such as this could be successfully completed with the leadership and resources of the Corps in close coordination, and with assistance from, State and local agencies and non-governmental organizations.

ALTERNATIVES

This section describes the various alternatives considered for this project to address the existing flooding and environmental problems in the San Joaquin basin. These alternatives were selected during the plan formulation process, explained in the reconnaissance report. Other potential alternatives were eliminated due to economic, environmental, and technical reasons.

No Action. Under the no-action plan, there would be no Federal participation in flood control and/or environmental restoration alternatives for increased levels of flood protection or restoration of historic natural resources. Levels of flood protection provided by the existing system would deteriorate, and potential damages due to flooding would increase from current levels. Despite increasing sediment deposition problems, it is assumed that no sediment would be removed from the mainstem of the San Joaquin River. However, significant sediment removal would probably continue in the Chowchilla and Eastside Bypasses. Limited vegetation removal within the river is likely using only hand labor. An estimated 220 acres of brush and upland habitat would be removed under the no-action alternative, but no removal of mature growth is anticipated. Other normal O&M activities are expected to continue, including repair of erosion areas and related structural problems. Given current restrictions to vegetation and sediment removal, it is likely that erosion and other structural stability problems along the levees would increase over time. These problems could lead to an increase in emergency repair work. The no-action alternative was assumed to be analogous to the without-project condition.

Channel and Levee Modification. This alternative includes activities that are not completed under the without-project condition. The alternative would be completed in two phases: (1) a 3-year comprehensive sediment and vegetation removal program to reestablish the flood control system to its original design and (2) a long-term maintenance program to ensure the integrity of the work completed during the 3-year program.

The first phase consists of removing a total of about 30,000 cubic yards of sediment along 70 miles of the San Joaquin

River and a total of 336 acres of vegetation. The vegetation to be removed includes about 104 acres of brush, 117 acres of upland habitat, and 115 acres of mature riparian growth. The work would be performed at numerous sites along the river. Table 1 lists the sites of the proposed work and includes existing vegetation, vegetation removed under the no-action plan, and vegetation removed under the Channel and Levee Modification alternative. Under no action, 50 percent of the existing brush and upland habitat vegetation is removed. Under the Channel and Levee Modification alternative, the remaining 50 percent of the brush and upland habitat vegetation and 100 percent of the mature growth is removed. Sediment is removed on about 270 acres of the same area. Due to current environmental constraints, all vegetation would be removed using hand labor and chipped or used for firewood.

The second phase consists of implementing a long-term maintenance program. The program includes removing 10 percent of the original 30,000 cubic yards of sediment (3,000 cubic yards) and 5 percent of the 336 acres of vegetation (17 acres) every 5 years over the life of the project.

In addition to removing sediment and vegetation, several activities involving structural repair, stabilization and removal of levees would be completed. Table 2 shows that a total of about 12 miles of toe drain and berms need to be modified to correct seepage problems. Seepage in these areas is caused by poor levee foundation soils or improperly designed and constructed levees. The levee repair at RM 67 is required to correct seepage, boils, and sloughing. The levee foundation has developed cracking and open fissures, and levee material would be removed and replaced.

This alternative, in conjunction with the O&M activities that would be carried out under the without-project condition, would provide continuous maintenance of channel capacities over the life of the project. These capacities would provide flood protection levels consistent with original design flows.

Full Diversion Areas. This alternative includes a series of temporary storage areas for floodwaters on lands adjacent to the San Joaquin River. Diversion of water to these areas reduces downstream peak flows. Adjacent areas are operated and managed in coordination with one another, creating a single system with numerous cells working together to divert, distribute, and direct the floodflows. These areas include Federal and State wildlife refuges, agricultural lands, and other privately owned properties. Floodwater is diverted into and drained out of the areas by 28 gated culverts. Inlet diversion structures would occupy 2.4 acres and outlet structures 0.1 acres. Historic sloughs, existing channels, levees, and irrigation canals are

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TABLE 1. CHANNEL AND LEVEE MODIFICATION ALTERNATIVE - INITIAL VEGETATION AND SEDIMENT REMOVAL

	EXISTING VEGETATION				NO ACTION ALTERNATIVE VEGETATION REMOVAL			CHANNEL & LEVEE ALTERNATIVE VEGETATION REMOVED			CHANNEL & LEVEE ALTERNATIVE SEDIMENT REMOVED	
RIVER MILE	TOTAL ACREAGE (ACRES)	MATURE GROWTH (ACRES)	BRUSH (ACRES)	UPLAND (ACRES)	MATURE GROWTH (ACRES)	BRUSH (ACRES)	UPLAND (ACRES)	MATURE GROWTH (ACRES)	BRUSH (ACRES)	UPLAND (ACRES)	VOLUME (CY)	AREA (ACRES)
132-133	6.82	0.51	4.56	1.75	0	2.28	0.875	0.51	2.28	0.875	107	6.5
133-135	23.57	6.75	10.02	6.8	0	5.01	3.4	6.75	5.01	3.4	467	8.75
135-137	15.06	1.73	5.47	7.86	0	2.735	3.93	1.73	2.735	3.93	278	8.95
137-139	18.39	3.29	6.99	8.11	0	3.495	4.055	3.29	3.495	4.055	247	6.09
139-141	13.14	2.61	4.2	6.33	0	2.1	3.165	2.61	2.1	3.165	207	7.36
141-142	12.25	1.81	5.05	5.39	0	2.525	2.695	1.81	2.525	2.695	230	11.38
142-144	52.36	6.91	14.05	31.4	0	7.025	15.7	6.91	7.025	15.7	388	15.07
144-147	40.3	7.9	16.66	15.74	0	8.33	7.87	7.9	8.33	7.87	255	11.6
147-148	9.47	1.79	3.09	4.59	0	1.545	2.295	1.79	1.545	2.295	92	0.75
168-169	9.4	0	4.11	5.29	0	2.055	2.645	0	2.055	2.645	465	7.48
169-171	11.98	0	1.38	10.6	0	0.69	5.3	0	0.69	5.3	237	2.7
171-173	9.22	0	0.72	8.5	0	0.36	4.25	0	0.36	4.25	201	4.02
173-175	0.49	0	0.49	0	0	0.245	0	0	0.245	0	226	7.96
175-176	0	0	0	0	0	0	0	0	0	0	37	2.7
176-178	10.81	0	1.81	9	0	0.905	4.5	0	0.905	4.5	169	33.33
178-179	6.6	0	0.85	5.75	0	0.425	2.875	0	0.425	2.875	169	10.61
179-181	5.97	0	0.97	5	0	0.485	2.5	0	0.485	2.5	249	9.4
181-183	34.49	3.85	10.53	20.11	0	5.265	10.055	3.85	5.265	10.055	1576	9
183-185	18.98	5.13	9.95	3.9	0	4.975	1.95	3.34	4.975	1.95	2522	14.02
185-186	16.6	3.5	10.02	3.08	0	5.01	1.54	3.5	5.01	1.54	468	9.55
186-187	19.61	4.33	9.95	5.33	0	4.975	2.665	4.33	4.975	2.665	789	11.81
187-190	16.29	7.57	8.37	0.35	0	4.185	0.175	7.57	4.185	0.175	460	16.28
190-192	26.15	6.16	12.24	7.75	0	6.12	3.875	6.16	6.12	3.875	516	8
192-194	19.24	4.45	9.01	5.78	0	4.505	2.89	4.45	4.505	2.89	700	10.5
194-196	23.91	6.21	9.7	8	0	4.85	4	6.21	4.85	4	15601	3.96
196-198	37.74	7.94	16.55	13.25	0	8.275	6.625	7.94	8.275	6.625	1197	7
198-200	29.78	5.74	10.63	13.41	0	5.315	6.705	5.74	5.315	6.705	699	9.5
200-201	39.66	16.55	11.11	12	0	5.555	6	16.55	5.555	6	449	6
201-205	30.01	11.85	10.16	8	0	5.08	4	11.85	5.08	4	453	5
TOTAL	558.29	116.58	208.64	233.07	0	104.32	116.535	114.79	104.32	116.535	29454	265.27

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TABLE 2

Channel and Levee Modifications
San Joaquin River Mainstem - Levee Work

WORK	LOCATION	DESCRIPTION	ALTERNATIVE SOLUTION
Structural Repair	Bear Creek - Junction Bear Creek, Eastside Canal, and Bear Creek project levee.	Bear Creek inlet structure improperly designed (flows cannot enter project levees due to structure being constructed too high).	Solution Being Developed under the Corps Ongoing Merced Stream Group Investigation.
Seepage/ Structural Stabilization	North Levee - River Mile 216.0 to 226.8. Six miles of levee.	Seepage due to improperly designed and constructed levees - cross section insufficient and constructed with native material/sand; foundations not properly keeled.	6 miles Toe drain and berm.
Seepage/ Structural Stabilization	River Mile 216 to 225. South levee San Joaquin River. About 5.75 miles of levee impacted.	Seepage due to improperly designed and constructed levees - cross section insufficient and constructed with native material/sand; foundations not properly keeled.	5.75 miles Toe drain and berm.
Levee Stabilization	River Mile 67.2 to 67.3.	Levee foundation cracking and open fissures on riverside slope. Significant levee settlement and near failure in 1983.	Complete additional studies to determine cause of problem and, if appropriate, carry out stabilization.
Levee Removal	River Mile??.	Existing levee on refuge property no longer serves purpose.	Breach levee to allow spreading of floodwater onto refuge lands.

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used to distribute and control the diverted floodflows to the proposed sites. In addition, at various locations, some low-lying berms are required to retain floodwater in storage areas. When full, these areas are designed to be drained over a 30-day period once water stages in the San Joaquin River recede to levels allowing gravity drainage. These areas would be used to control floods with frequencies between the 10- and 60-year event. Floods larger than the 60-year event exceed the capacity of the system, and flooding would follow natural historic patterns.

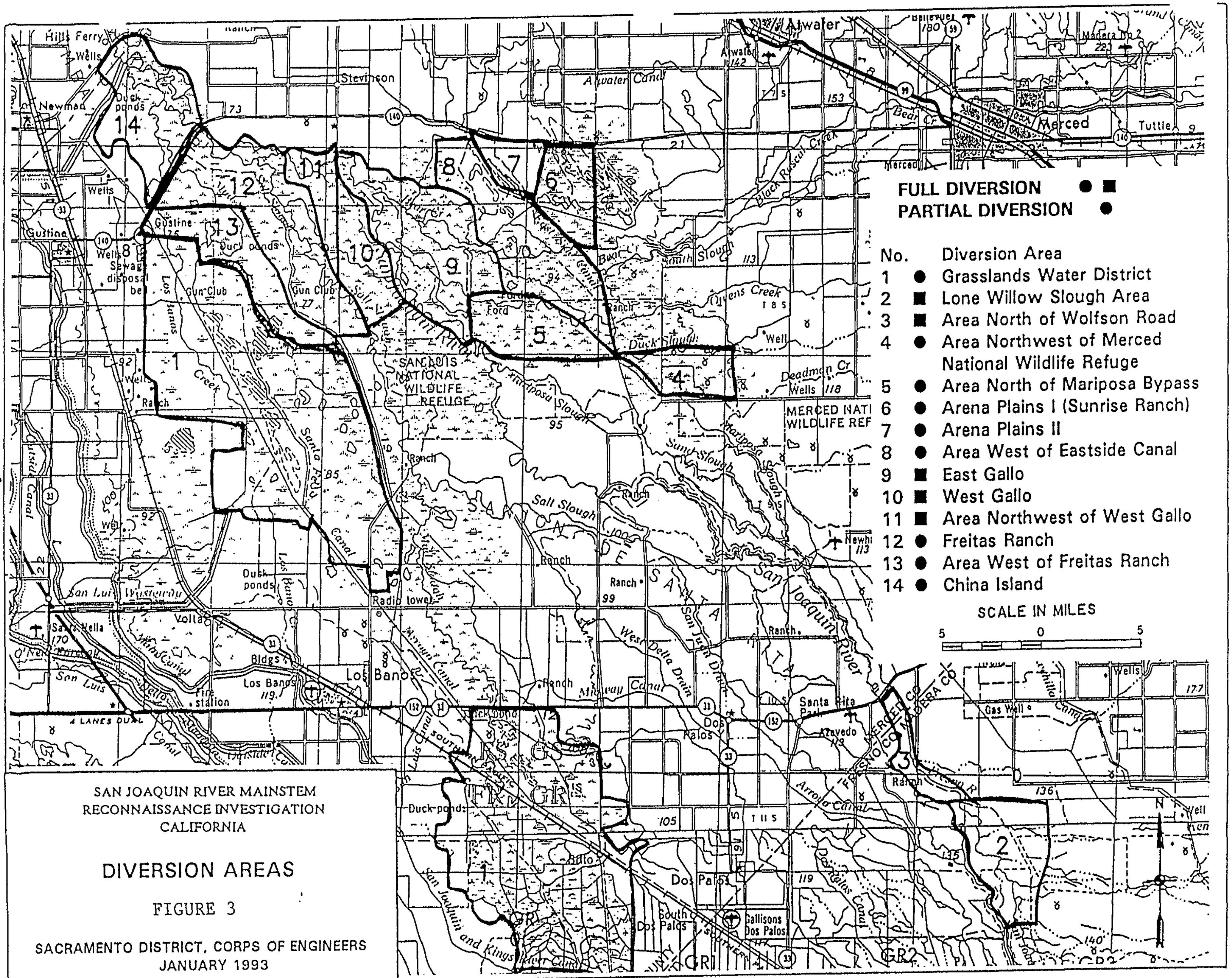
Figure 3 shows the locations of the diversion areas, listed below. These areas total approximately 109,000 acres and have a storage volume of over 200,000 acre-feet.

- Arena Plains I (Sunrise Ranch)
- Arena Plains II
- Freitas Ranch
- Area North of Mariposa Bypass (Elevation 90)
- China Island
- Grasslands Water District
- Area West of Eastside Canal
- Area Northwest of West Gallo Property (Elevation 75)
- Area West of Freitas Ranch
- Area Northwest of Merced National Wildlife Refuge (Elevation 100)
- Area North of Wolfson Ranch
- Lone Willow Slough Area
- West Gallo Property
- East Gallo Property

Partial Diversion Areas. This alternative is similar to the Full Diversion Areas alternative. However, this alternative includes only those diversion areas that are currently owned or have easement rights retained by the Federal or State Government and the privately-owned Grasslands area. The areas with a current government land interest include:

- Arena Plains I (Sunrise Ranch)
- Arena Plains II
- Freitas Ranch
- Area North of Mariposa Bypass (Elevation 90)
- China Island
- Area West of Eastside Canal
- Area West of Freitas Ranch
- Area Northwest of Merced National Wildlife Refuge (Elevation 100)

In 1986, the privately-owned Grasslands area applied to the State Water Resources Control Board for the right to divert floodwaters. Based on this action and its current interest in participating in a flood control/environmental restoration



SAN JOAQUIN RIVER MAINSTEM
RECONNAISSANCE INVESTIGATION
CALIFORNIA

DIVERSION AREAS

FIGURE 3

SACRAMENTO DISTRICT, CORPS OF ENGINEERS
JANUARY 1993

project, the Grasslands area was included in the Partial Diversion Areas alternative. These areas cover a total of 88,490 acres and have a combined storage volume of 129,845 acre-feet. The FWS is currently trying to purchase two additional areas, the East and West Gallo properties. Should these be acquired, they could be added to this alternative. The two Gallo areas would add 47,150 acre-feet of storage over a 11,470-acre area. Inflow and drainage facilities for these diversion areas would be the same as for the Full Diversion alternative. Eighteen gated culverts would be required to divert and drain floodwaters.

Environmental Restoration with Flood Control. This alternative combines environmental restoration projects with the diversion of floodwaters, enabling the restoration areas to benefit from receiving intermittent floodwater while realizing incidental flood control benefits. The following diversion areas from Figure 3 would be utilized: China Island, Grasslands Water District, Arena Plains I, Arena Plains II, and the Area West of the East Side Canal. These areas total 59,730 acres and have a storage volume of 69,500 acre-feet. Ten gated culverts would be required to divert and drain floodwaters. The environmental restoration projects allow the restoration of wetland and riparian habitats within these areas under dry, normal, and wet water years. The addition of the flood control diversions allows the use of floodwater as a water supply during wet years.

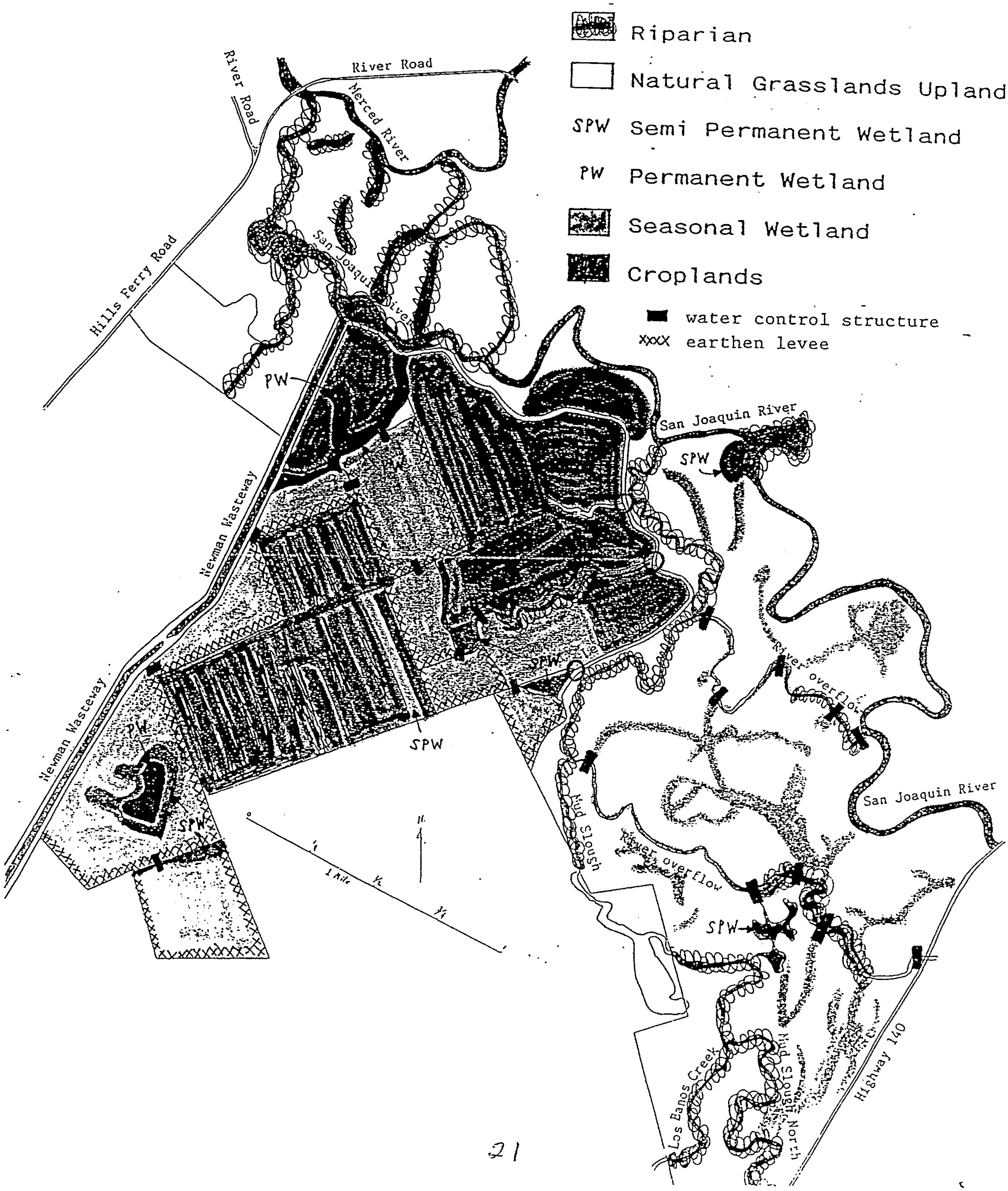
The environmental restoration projects described below could be done separately or in combination. All but one of these potential projects is in the Grasslands/Los Banos area. (see Figure 2) These proposed projects meet the objectives of the CVHJV, SJRMP, the San Joaquin Basin Action Plan, FWS, the U.S. Bureau of Reclamation, CDFG, the State Wildlife Conservation Board, and the Grasslands Water District.

China Island. - Historic wetlands and riparian habitat on the China Island unit of the North Grasslands Wildlife Area would be restored. This unit is owned by CDFG and includes about 3,300 acres of land southwest of the San Joaquin River above its confluence with the Merced River (Figure 4). This land is within the historic San Joaquin River flood plain and flooded annually prior to the completion of upstream dams. Now it floods only in very wet years, such as 1983, except for 1,400 acres which is protected by a local levee. For the most part, the land no longer displays wetland characteristics (hydrophytic vegetation) and resembles valley grasslands. Mud Slough North and two river overflow channels cross this property. Riparian vegetation is nonexistent or severely degraded along these watercourses. Few acres of wetland habitat remain.

The present land surface consists of 1,100 acres of leveled formerly irrigated agricultural fields between the local levee

FIGURE 4. CHINA ISLAND UNIT
NORTH GRASSLANDS WILDLIFE AREA

Proposed Habitat Management
& Development



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and the Newman Wasteway; 300 acres of former duck club property southwest of the agricultural fields; and 1,900 acres of degraded flood plain, dry channels, and degraded riparian corridors along Mud Slough North, San Joaquin River, and Merced River.

Figure 4 shows the conceptual habitat development and management plan for the China Island unit. Wetlands and riparian vegetation would be restored by diverting surface waters and pumping ground water onto this land. The plan includes the creation of 600 acres of seasonal and semi-permanent wetlands on the agricultural land, with the remaining 500 acres used to grow waterfowl food crops and provide nesting cover. The 300-acre duck club would be restored to seasonal and permanent wetlands; the 1,900 acres of flood plain would become seasonally flooded and semi-permanent wetlands with continually flooded riparian corridors.

The plan would require constructing many features to move and manage water. Features to convert the former agricultural lands into wildlife habitat include 66,000 feet of low earthen levees (3 feet high with a 12-foot crown) to separate the land into management cells and water control structures (gated culverts) within the levees to manage water movement. The local levee which separates the agricultural lands from the flood plain would need to be breached in two or three places and flood gates installed to permit the former agricultural lands to flood during high flows. In addition, an existing 6,120-foot-long earthen water supply canal would be rebuilt with concrete or replaced with a pipeline to ensure adequate water delivery to this area.

To divert and hold water in existing depressions in the flood plain, culverts with risers and flood gates would be installed on Mud Slough North, the river overflow channels, and within some depressions. Including the water control structures within the agricultural lands, approximately 30 culverts and 217 flood gates would be installed. Other work on the flood plain acreage would consist of planting almost 600 acres of riparian vegetation along the San Joaquin River, Mud Slough, and the river overflow channels. Native riparian species such as cottonwood, willow, wildrose, and buttonbrush would be planted, and irrigation facilities such as ditches and pipes would be constructed.

Grasslands Water District. - The Grasslands Water District provides water to about 50,000 acres of land, most of it wetlands owned by duck clubs. (see Figure 2) About 30,000 acres of this land is under FWS conservation easements. With this component, historic wetlands and riparian habitat would be restored in four areas in the district: (1) the Menezes Property, approximately 1,520 acres by the San Luis Spillway Ditch and Los Banos Creek; (2) the Ornallas-Carlucci-Silva Properties, approximately 930 acres west of the Los Banos Wildlife Management Area; (3) the

Amabile-Sansoni Property, approximately 640 acres east of the Santa Fe Canal and north of Highway 152; and (4) the Thiercoff Ranch, approximately 800 acres west of the Santa Fe Canal south of Highway 152. Figure 5 shows the locations of these areas and some of the proposed features.

The environmental restoration work would consist of excavating deep and shallow basins and other topographic modifications to restore about 3,020 acres of semi-permanent and seasonal wetlands and enhance an additional 780 acres; revegetating 90 acres of riparian habitat; constructing 119,000 feet of low earthen levees or dikes around individual parcels; designing and constructing 50 to 55 water control/diversion structures (screw gates, flash board risers, and culverts); and designing and constructing over 25,000 feet of earthen canals. These features would enable water to be delivered to newly created wetlands and allow for water management in individual areas. These features would also enhance the management and productivity of existing wetlands. An additional 84,000 feet of new canal would be needed to allow water delivery from existing supply canals to the new features, thus ensuring an adequate supply.

Arena Plains National Wildlife Refuge/FWS Easement Lands. - The FWS has recently purchased 2,700 acres of land (Sunrise Ranch) south of Highway 140 and north of the Eastside Canal and created the Arena Plains National Wildlife Refuge (NWR). The FWS also has over 8,800 acres of land under conservation easement in this general area east of the San Joaquin River. These lands are shown as areas 6, 7, and 8 on Figure 3. With this project wetlands and riparian habitat would be restored on former agricultural land and along degraded channels within these areas.

Work would include rehabilitating water delivery systems, rehabilitating levees, installing water control/diversion structures, and creating shallow basins. About 400 to 600 acres of irrigated pasture would be excavated to create additional wetlands, and these excavated areas would be revegetated with bulrush, smartweeds, and perennial grasses.

Specific features would include one 1,320-foot-long connecting canal between Bear Creek and the Atwater Drain to divert high water flows into the Atwater Drain (250-cfs capacity); two inline water diversion structures on Bear Creek; four inline water control/diversion structures on the Atwater Drain in the Arena Plains NWR; two water control/diversion structures on an old extension of the Atwater Drain; two water control/diversion structures in the Eastside Canal west of the Arena Plains NWR; and one water control structure on the eastern boundary of the Arena Plains NWR by the Wilkinson Duck Club. These structures would supply water to, and control water levels

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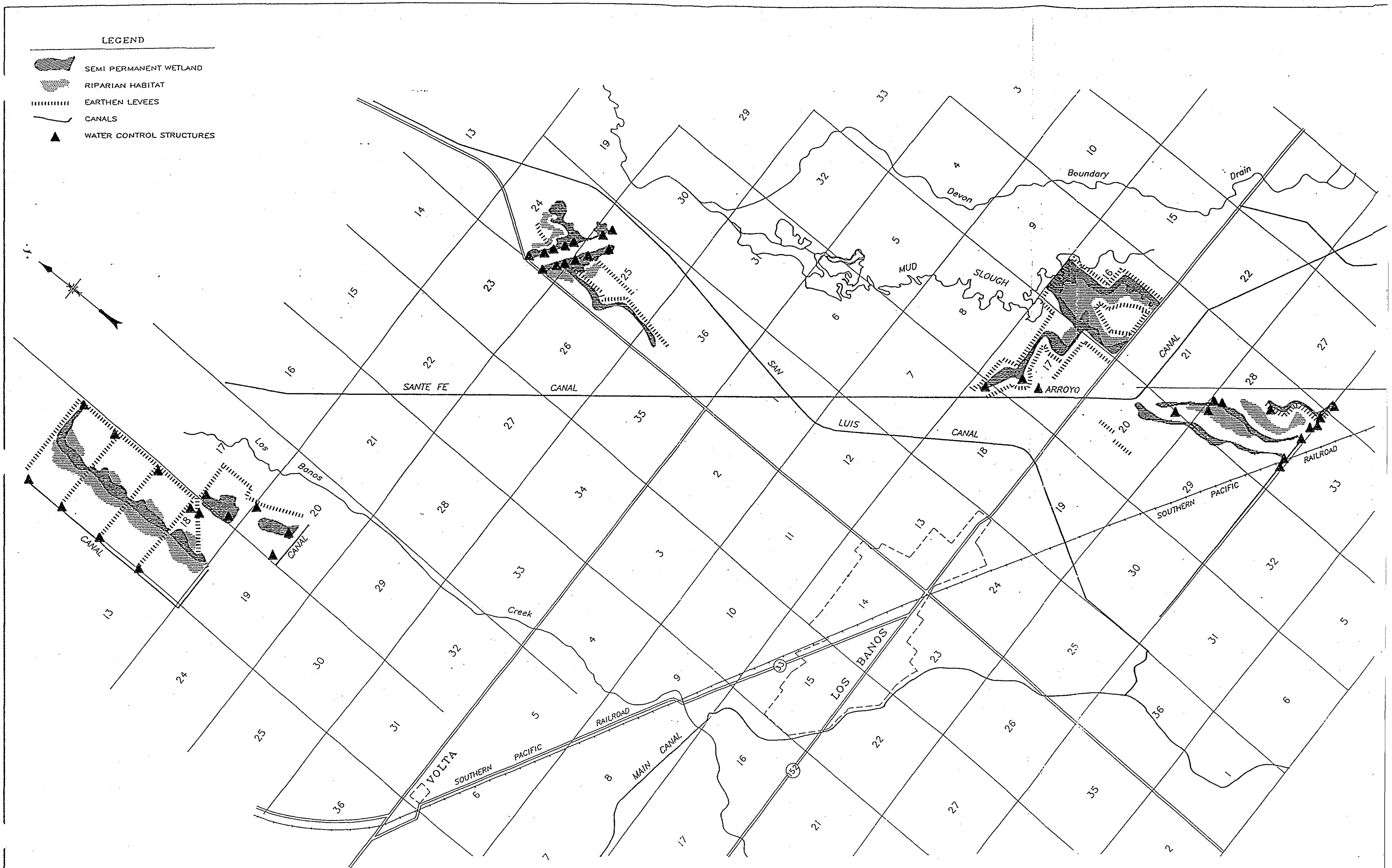

FIGURE 5. WETLAND RESTORATION SITES, GRASSLAND WATER DISTRICT

within, the Arena Plains NWR and the easement properties. Approximately 15 culverts with risers would be placed at various locations to enable further management of water levels in various areas.

San Joaquin River (RM 63 to RM 70). - With this project riparian habitat, including shaded riverine aquatic (SRA), would be restored at selected sites along the mainstem. Table 3 lists the locations and acreage of the areas to be planted with riparian vegetation. It is anticipated that this revegetation project would eventually create 19,000 linear feet of SRA habitat. The areas listed in Table 3 are all below the mouth of the Stanislaus River and are within the San Joaquin River floodway. The riparian vegetation at these areas is either absent or severely degraded. The proposed restoration areas formerly supported healthy riparian communities.

Native riparian trees and shrubs would be planted and irrigation facilities installed on about 170 acres. Fencing could also be constructed to assist in managing these areas for habitat preservation. The local cost-sharing sponsor(s) would be required to secure these areas in fee or easement to ensure long-term protection. Erosion control work may be needed to protect some of the new riparian areas. This would involve the construction of berms or other bank protection. This revegetation project would provide incidental flood protection to agricultural lands in the area that are experiencing seepage problems and help protect levees that are being threatened by erosion.

ENVIRONMENTAL SETTING

The discussion of study area resources is divided into sections. Existing resources not likely to be significantly affected by the alternatives are discussed in this section. Significant resources that are likely to be affected by study alternatives are discussed in sections "Vegetation" through "Cultural Resources." Table 8 summarizes potential impacts on significant resources from the study alternatives.

Climate. The climate of the basin is characterized by wet, cool winters, dry, hot summers, and relatively wide variations in relative humidity. In the valley area relative humidity is very low in the summer and high in the winter. The characteristic wet winters and dry summers are due principally to a seasonal shift in the location of a high pressure air mass ("Pacific high") that usually exists a thousand or so miles west of the mainland. In the summer the high blocks or deflects storms; in the winter it often moves southward and allows storms to reach the mainland.

TABLE 3. SAN JOAQUIN RIVER REVEGETATION AREAS.

Areas	Approximate Acres
Three fields at RM 63, east bank	37
Area south of Banta-Corbona Canal, RM 64 to 64.5, west bank	24
Field at bend, RM 65, east bank	17
Bare areas, RM 66.5, east bank south of oxbow, and east bank of oxbow	38
Thin field, RM 67, east bank	10
Small area north of pond, RM 68, east bank	6
RM 69-70, west bank	40
TOTAL	172

Temperatures in the basin vary considerably because of seasonal changes and the large range of elevations. Temperatures in the lower elevations are normally above freezing but range from slightly below freezing at times during the winter to highs of over 100 degrees Fahrenheit at times during the summer. At intermediate and higher elevations, the temperature may remain below freezing for extended periods during the winter.

Precipitation is unevenly distributed throughout the basin. About 90 percent of the precipitation falls during the months of November through April, and precipitation is negligible during the summer, particularly on the valley floor. Normal annual precipitation varies from 6 inches near Mendota to about 70 inches at the headwaters of the San Joaquin River. In the higher elevations of the Sierra Nevada, precipitation occurs principally as snow and in the rest of the basin as rain, with mean values of approximately 20 inches. Basins on the east side of the Coast Range lie in a rain shadow and receive considerably less precipitation than do basins of similar altitude on the west side of the Sierra Nevada.

Geology, Topography, and Soils. The San Joaquin Basin lies within parts of the Sierra Nevada, California Coast Range, and the Great Central Valley geomorphic provinces. Its sedimentary, metamorphic, and igneous rocks range in age from pre-Cretaceous to recent nonwater-bearing crystalline rocks. In the California Coast Ranges, Jurassic and Cretaceous sandstones and shales dominate. In the valley, upper Tertiary and Quaternary sediments in places contain freshwater as deep as 2,000 feet. Also, in most of the area impermeable Corcoran clays confine the lower water-bearing zone.

The basin lies between the crests of the Sierra Nevada and Coast Range and extends from the northern boundary of the Tulare Lake basin, near Fresno, to the southern boundary of the Sacramento-San Joaquin Delta, near Stockton. The basin is drained by the San Joaquin River and its tributary system. The basin has an area of about 14,000 square miles, extending about 100 miles from the crest of the Sierra Nevada and about 120 miles from the northern to southern boundaries. The Sierra Nevada has an average crest elevation of about 10,000 feet with occasional peaks as high as 13,000 feet. The Coast Range crest elevations reach up to 5,000 feet. The valley area measures about 100 miles by 50 miles and slopes gently from both sides towards a shallow trough somewhat west of the center of the valley. Valley floor elevations range from about 250 feet near Mendota to sea level near Stockton. The trough forms the channel for the lower San Joaquin River and has an average slope of about 0.8 foot per mile between the Merced River and Paradise Cut and an average slope of about 1.6 feet per mile from Friant Dam to the Merced River.

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Soils in the valley basin bottoms are poorly drained and fine textured. Some areas are affected by salts and alkali and require reclamation before they are suitable for crops. Bordering and just above the basin bottoms are soils of the fans and flood plains. They are generally level, very deep, well drained, non-saline and non-alkaline, and well suited to a wide variety of crops. The soils of the terraces bordering the outer edges of the valleys generally are of poorer quality and have dense clay subsoils or hardpans at shallow depths. These soils are generally used for pasture and rangeland.

Soils in the foothills and mountains of the Sierra Nevada are generally shallow or moderately deep to bedrock, acid in reaction, medium to coarse textured, and gravelly or rocky. Above timberline are broad expanses of exposed rock on the ridges and peaks. Soils in the Coast Range are generally moderately deep to shallow and fine to coarse textured. Soils are rocky at higher elevations.

Hydrology. The San Joaquin River and tributaries have a drainage area of about 14,000 square miles (excluding the Kings River). Major tributary streams, from north to south, are the Cosumnes, Mokelumne, Calaveras, Stanislaus, Tuolumne, and Merced Rivers. These streams, plus the San Joaquin River, carry the major portion of the surface runoff in the basin. Minor streams on the east side of the valley are the Fresno and Chowchilla Rivers and Burns, Bear, Owens, and Mariposa Creeks. Panoche, Little Panoche, Los Banos, San Luis, Orestimba, and Del Puerto Creeks comprise the minor streams on the west side. These tributaries contribute very little to the runoff of the San Joaquin River, except for floodflows during intense storms. During high runoff periods, a distributary channel of the Kings River (called James Bypass) discharges water into the San Joaquin River near Mendota. In addition, floodwater is diverted to the San Joaquin River from Big Dry Creek Reservoir near Fresno. Flows from rivers and creeks are significantly reduced by storage, diversions, and channel seepage losses as they cross the valley floor so that only a portion of the water at the foothill line reaches the San Joaquin River. Peak flows from these tributaries usually do not coincide and, consequently, the combined capacity of tributary channels is considerably greater than that of the lower San Joaquin River.

Streamflow and reservoir records have been maintained for varying periods of time at many locations throughout the basin. The average annual floodflow from the river tributaries is about 7 million acre-feet from both rainfall and snowmelt. During the 1983 water year, flows were on the order of 19 million acre-feet. Flows from the rivers and creeks are significantly reduced by diversions and channel seepage losses as the creeks flow across the valley floor, and only a portion of the flows at the foothill line reach the San Joaquin River. Because of this and other

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water uses in the basin, the average flow at Vernalis on the Lower San Joaquin is about 3 million acre-feet. Flows as high as 80,000 cfs have been recorded at the Vernalis streamflow gage where the mean annual floodflow is about 25,000 cfs. Controlled flows from Friant Dam measured at Gravelly Ford are 8,000 cfs. A flow of about 10,000 cfs was recorded at the Gravelly Ford gage in 1983. Average annual flows at this location are well below 1,000 cfs.

Land Use. The overall study area is rural with large ranches. Agriculture is the economic base of this area. Over 50 percent of the land in all five counties is currently used for agriculture (Table 4). Land along the San Joaquin River is mainly agricultural, growing a variety of crops with a very high production value (Table 4). In some areas crops are grown adjacent to the river's edge. Soils in the study area are highly productive, and most of the land is actively being cultivated.

Much of the agricultural land is held under contracts from The California Land Conservation Act of 1965 (commonly known as the Williamson Act). This act established a voluntary tax incentive program for preserving agricultural and open space lands. A property owner enters into a 10-year contract with the county, which places restrictions on the land in exchange for tax savings. Williamson Act contracts are renewed automatically each year unless they are canceled or a Notice of Nonrenewal is filed with the State. Approximately 70 percent of San Joaquin County lands are under the Williamson Act contract. The other counties in the study area have a similar proportion of Williamson Act lands.

Urban development is concentrated in and around the major cities of the study area and is increasing due to the low cost of land, housing, and the close proximity to the job markets in Sacramento, San Jose, and the San Francisco Bay area. Counties in the study area are working to accommodate new urban development and planned industrial growth. According to county general plans, most of the growth is planned for areas adjacent to Highway 99, Interstate 5, and near existing urban centers.

Counties within the study area are attempting to preserve the agricultural lands. The general plans for the counties suggest that a balance between rural/agricultural and urban development needs to be accomplished. The goal of these counties is to provide for the long-term conservation and use of agricultural lands and support land under the Williamson Act while allowing for the expansion of existing urban areas and services.

Air Quality. The study area is within the San Joaquin Valley Air Basin (SJVAB). Air quality is generally poor to marginal; the basin is not in compliance with State of California and Federal

TABLE 4
AGRICULTURAL ACREAGE AND PRODUCTION VALUE

COUNTY	ACREAGE IN FARMS 1989	PERCENT OF LAND AREA	VALUE OF PRODUCTION 1989 ($ MILL.)
FRESNO	1,975,373	51.7	2,603
MADERA	757,263	55.2	471
MERCED	1,049,302	82.7	1,050
SAN JOAQUIN	823,729	91.3	871
STANISLAUS	719,845	75.0	963
CALIFORNIA	30,598,178	30.5	20,671

Source: California Department of Finance, Economic Research
October 1991

standards for ozone and fine particulate matter (PM-10). The basin as a whole is designated a nonattainment area for ozone and PM-10 and has not met State and Federal standards for over 15 years (San Joaquin Valley Unified Air Pollution Control District [SJVUAPCD], 1992). In 1990, the valley exceeded the Federal ozone standard on 45 days and the State standard on 130 days (SJVUAPCD, 1992). Fresno, Modesto, and Stockton are nonattainment areas for carbon monoxide (CO) and have been for over 10 years. In 1990, Fresno exceeded the State standard on 1 day, Modesto on 3 days, and Stockton on 7 days.

Air quality problems are the result of the region's geographic location, topographic features, climatic conditions, population growth, and economic activities. These combine to make the SJVAB both a receptor and contributor of transported air pollutants. The SJVAB is most affected by transported air pollution from the Sacramento and San Francisco Bay areas, and its own Stockton, Modesto, and Fresno metropolitan areas. Contributions from these areas consist mostly of ozone and CO, primarily from automobile exhausts. Valley agricultural operations such as plowing and burning introduce the bulk of the particulates into the air.

Plans have been developed to try to address air quality problems and bring the SJVAB and metropolitan areas into compliance with State and Federal standards. However, air quality will continue to be poor to marginal in the near future due to the lack of control over and increases in the major sources of pollution (i.e., automobiles, areas outside the basin). In addition, rapid growth will continue in the San Joaquin Valley which will exacerbate air quality problems. The SJVAB is so far out of compliance with State and Federal standards that attainment status will be very difficult to achieve.

Esthetics. The native ecosystems of the San Joaquin River Valley have been considered a significant esthetic resource since the time of western exploration and settlement. Early explorers such as Fremont, Carson, and Grayson describe the oak woodlands and riparian forests in glowing accounts, even going so far as to say the valley contained some of the most pleasing and beautiful country they had ever travelled through (SJVDP, 1990). These explorers also expounded on the beauty and abundance of the numerous wildlife species present, such as elk, antelope, bear, beaver, swan, geese, and ducks. Fremont summed up the early sentiment, calling the valley fresh, verdant, sylvan, and more bounteously watered and alive with animals than any place one might travel the world over. On the valley floor, the San Joaquin River corridor has historically been the esthetic focal point because of its water, riparian forest, and fish and wildlife.

Natural areas and valley wildlife continue to be an important esthetic resource, perhaps more so now than in the past because of the scarcity of these resources. The conversion of extensive areas of native ecosystems and the subsequent decline of wildlife species and populations have made the remaining natural areas and wildlife proportionally more esthetically valuable. In addition, natural areas and wildlife provide an extreme contrast to the homogenous agricultural landscape that is the San Joaquin Valley. Most remaining natural lands on the valley floor are within or close to the San Joaquin River corridor.

Socioeconomic Conditions. Counties within the study area include Fresno, Madera, Merced, San Joaquin, and Stanislaus which are all within the San Joaquin Valley Basin. Populations in these counties have increased at a faster rate than the State average, and this increase is projected to continue (Table 5). Most of the cities within the study area have also grown at a rapid rate over the past 20 years (Table 6). The growth rate for these counties is greater than the growth rate for the state of California, which averages 32 percent.

Many of the people who currently live in the major cities of the study area commute to jobs in Sacramento, San Jose, and the San Francisco Bay area. A recent study conducted by the San Joaquin Council of Governments indicates that 80 to 90 percent of recent homebuyers in the Tracy, Manteca, and Ripon areas originated west of the Altamont Pass. This trend is expected to continue with future residents. Due to this phenomenon past unemployment rates in these counties have been much higher than the State average.

All of the cities within the study area are provided police services from either their own police departments or the County Sheriff's Department. Due to the scattered nature of residential development, response time in many of the counties can be long. Fire protection is provided by fire departments with mostly volunteer firefighters in all the cities except for Merced and Madera, which have mostly paid firefighters. During the fire season, May 15 to November 1, the U.S. Forest Service and the California Division of Forestry provide additional manpower and equipment to these counties.

All of the cities in the study area have individual school districts with the exception of Lathrop. Schools in Lathrop are maintained by the Manteca Unified School District. Both elementary and high school facilities are overcrowded in many of the districts.

General plans for these counties have addressed the impacts of the anticipated growth and are attempting to maintain the existing conditions of public services. The plans include

TABLE 5
COUNTY POPULATION

COUNTY	1970	1990	Percent Increase 1970-1990	2035*	Percent Increase 1990-2035
FRESNO	413,053	667,490	38	1,129,300	41
MADERA	41,519	88,090	53	204,500	57
MERCED	104,629	178,403	41	424,000	58
SAN JOAQUIN	290,208	480,628	40	1,021,000	53
STANISLAUS	194,506	370,522	47	679,200	45
CALIFORNIA	20,039,000	29,976,000	33	44,542,500	32

* California Department of Finance, Population Research Unit

Source: California Cities, Towns, & Counties Basic Data Profiles for all Municipalities & Counties, 1992

TABLE 6
CITY POPULATION

CITY	COUNTY	POPULATION		
		1970	1990	Percent Increase 1970-1990
FIREBAUGH	FRESNO	2,517	4,429	43
MENDOTA	FRESNO	2,705	6,821	60
MADERA	MADERA	16,044	29,281	45
DOS PALOS	MERCED	2,496	4,196	40
GUSTINE	MERCED	2,793	3,931	29
LOS BANOS	MERCED	9,188	14,519	37
MERCED	MERCED	22,760	56,216	60
LATHROP	SAN JOAQUIN	N/A	6,841	N/A
RIPON	SAN JOAQUIN	2,679	7,455	64
NEWMAN	STANISLAUS	2,505	4,151	40
PATTERSON	STANISLAUS	3,147	8,626	63

Source: California Cities, Towns, & Counties Basic Data Profiles for all Municipalities & Counties, 1992 additional housing, schools, water systems, and other public facilities.

Recreation Resources. The San Joaquin River system exists as the primary source of recreation for millions of people each year. A wide range of recreation activities can be enjoyed within, along, or near the San Joaquin River and its main tributaries. The San Joaquin, Tuolumne, Stanislaus and Merced Rivers and adjacent areas offer a variety of water-based and land-based leisure activities, including fishing, hunting, swimming, boating, golf, picnicking, and sightseeing. These recreational opportunities are available in both the public and private sector throughout the year.

Several recreational areas exist between Friant Dam and Highway 99. Two miles below Friant Dam and the Millerton Lake State Recreation Area is Lost Lake Regional Park, operated by theFresno County Parks Division. The 305-acre park includes a 42-space campground, 38-acre lake, picnic and barbecue areas, softball field, children's playgrounds, and a nature trail. The park has good access to the Fresno County side of the San Joaquin River and is used as a canoe put-in site (2M Associates, 1989). Woodward Park, operated by the City of Fresno, lies above the bluffs overlooking the San Joaquin River. Facilities at this 265-acre urban park include picnic shelters, Japanese gardens, and open playfields. Skaggs Bridge Regional Park, also operated by the Fresno County Parks Division, is a 17-acre park west of Highway 145 for day use and beach and fishing activities. Facilities include individual and group picnic areas and restrooms. There are three golf courses between Friant Dam and Highway 99: Riverside Municipal Golf Course, San Joaquin Country Club, and Fig Garden Golf Club.

In the Grasslands/Los Banos area, three National Wildlife Refuges (Kesterson, San Luis, and Merced) and the State of California Los Banos Wildlife Area allow the recreationist to take part in birdwatching, photography, and even sight-seeing along a designated auto tour. These four sites of Merced County, plus the surrounding area of bypasses, canals, creeks, and the San Joaquin River, also support an abundance of duck and hunting clubs. Over 150 clubs within a 15-mile radius of Los Banos utilize the rich waterfowl area for hunting.

There are several parks in this area as well. Hagaman County Park, operated by the County of Merced, is at Highway 165 and the Merced River. The 15-acre park has picnic and barbecue areas, two recreational playing fields, and a playground. In the northwest portion of Merced County, George J. Hatfield State Recreation Area and Fremont Ford State Recreation Area are less than 5 miles apart from each other. Hatfield is a 47-acre site located on the Merced River with 21 developed campsites and picnicking and fishing areas. Fremont Ford, on the San Joaquin

River, is a 114-acre area that features fishing only. Both recreation areas are owned and operated by the State of California.

The County of Stanislaus operates three fishing access sites. Las Palmas Fishing Access, located on the San Joaquin River east of Patterson, is a 5-acre site with 1,400 feet of river frontage and a boat ramp. Shiloh Fishing Access, a 1.25-acre site, and Riverdale Fishing Access, a 2.5-acre site of undeveloped river frontage, are on the Tuolumne River west of Highway 99. Also along the Tuolumne River west of Highway 99 is a large undeveloped site owned by the City of Modesto. The Tuolumne River Regional Park is planned for this site. The City of Modesto does operate a 9-hole Municipal Golf Course and the 18-hole Dryden Municipal Golf Course along the river.

Caswell Memorial State Park, owned and operated by the State of California, is located on the north side of the Stanislaus River 6 miles southwest of Ripon. The 258-acre park has 65 developed campsites, picnic facilities, a nature walk, and exhibits. Fishing, hiking, and swimming can also be enjoyed at the park. Five miles west of Caswell Memorial State Park is Durham Ferry State Recreation Area, owned by the State of California and operated by San Joaquin County. The 207-acre park has a total of 76 campsites, large day-use areas, and picnic shelters.

Recreation within the study area of the San Joaquin River and its tributaries is directly related to the water. This is reflected by the fact that over 90 boat launching facilities and over 500 boat storage facilities exist in the study area (Williams-Kuebelbeck, 1986). As the quality and amount of water decrease, so do the quality and amount of recreational opportunities. The historic, current, and future "demand for recreation is due to the natural resource values that exist along the river. It is the natural beauty, wildlife and landscape diversity that attract people to the river. Preserving the natural resources will be the key to being able to satisfy the demand for recreation" (Dangermond & Associates, 1992).

Hazardous, Toxic, and Radioactive Waste (HTRW) Sites. A literature review focusing on State and Federal lists of uncontrolled hazardous waste sites indicated that numerous HTRW sites exist in the study area. However, most of the listed sites involve minor tank leaks and are not located in any areas where flood control plans, environmental restoration, or environmental mitigation are being considered.

A field reconnaissance and review of aerial photos of the study area would be conducted during feasibility studies to determine if any unlisted HTRW sites are in the area. Results of this work and an updated literature survey would be coordinated

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formally with the non-Federal sponsor and appropriate Federal, State, and local agencies. In addition, the Corps would develop a contingency plan identifying a responsible agency and outlining a course of action in the event that HTRW sites are uncovered during construction.

VEGETATION

Existing Conditions. In general, the historic natural vegetation of the San Joaquin River Valley consisted of an extensive belt of riparian forest and willow thickets along perennial streams, lakes, or sloughs; extensive areas of freshwater wetlands and tule marshes; oak savanna within the 100-year flood plain; California prairie and grasslands in upland areas; and San Joaquin saltbush on more xeric alkaline sites. Figure 6 illustrates the historic locations of these natural habitat communities. Unique vernal pool, alkali sink, and alkaline grassland communities formed in areas where water ponded during winter and spring. This mosaic of natural habitats and plant communities was rich in species and diverse in structure.

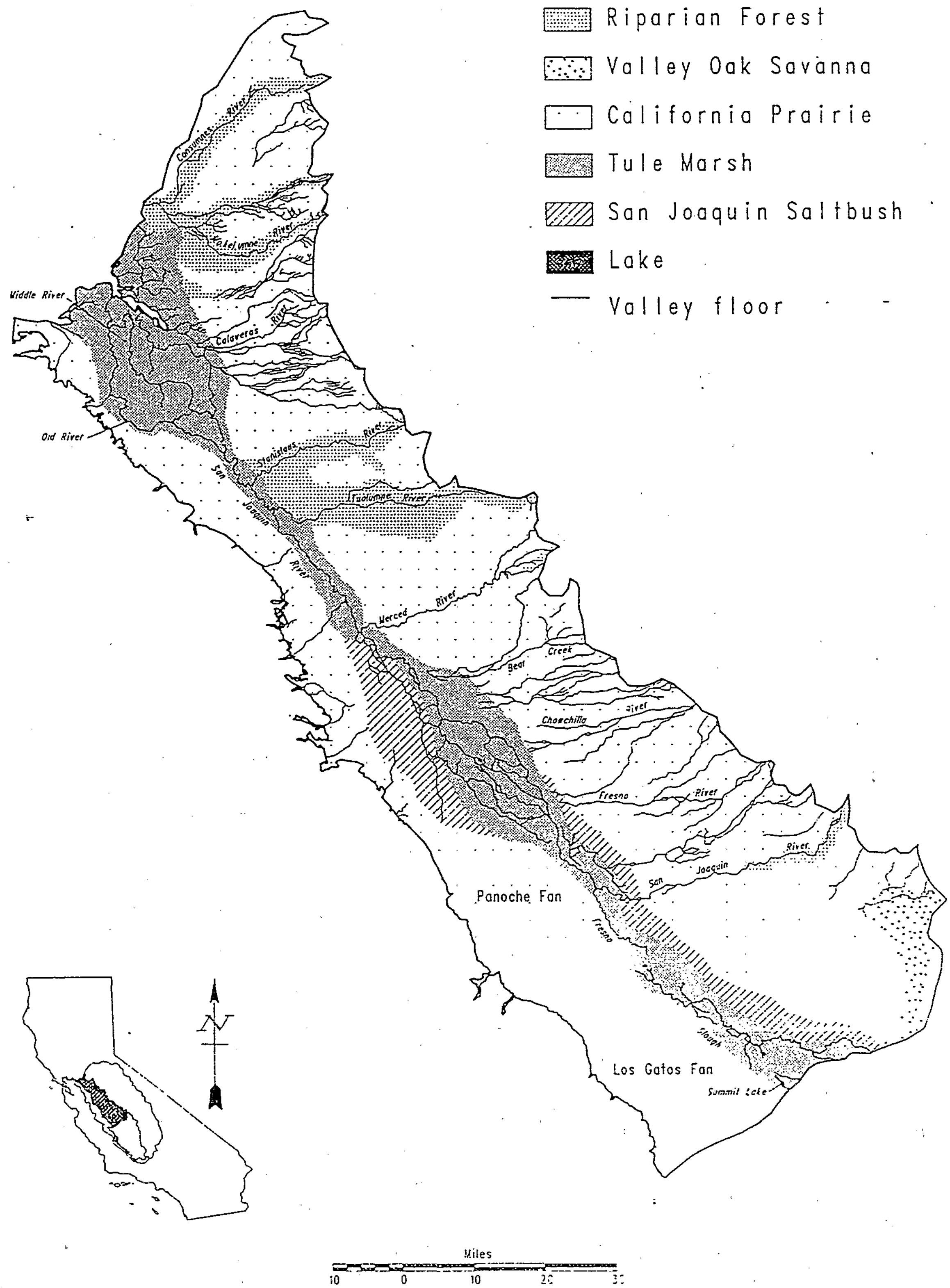
Today the San Joaquin Valley contains the largest contiguous block (roughly 4.7 million acres) of irrigated land in California. Almost 60 percent of the valley floor is in agricultural use (USDA, 1977). Conversion of natural areas to intensive agricultural use continues. The natural habitats are only a fraction of their former extent. Figure 7 and Table 7 show how the natural landscape of the San Joaquin Valley has changed over time and how much acreage in natural habitats remains. Riparian and wetland habitats are discussed in greater detail below due to their ecological and institutional significance. These habitats are the most important habitat types found in the study area and are critical to fish and wildlife throughout the San Joaquin Valley.

Riparian. As mentioned earlier, riparian habitat in the San Joaquin Valley has been reduced to 4 percent of its pre-European settlement extant of over 900,000 acres. Thus, the valley contains approximately 36,000 acres of riparian habitat, much of which is disturbed or degraded. Most remaining riparian habitat is located along the San Joaquin River and the lower Stanislaus and Tuolumne Rivers.

Riparian habitat is very fragmented and less diverse than previously. Many of the existing riparian communities are dominated by a few primary plant species in structural patterns with a wide range of age classes. Overstory species include cottonwood, sycamore, willow, and valley oak. Intermediate and understory species include box elder, willow, elderberry, wild grape, poison oak, wild rose, and California blackberry. Riparian habitats are in a state of perpetual succession due to

Figure 6.

Historic Hydrography and Natural Habitats of the San Joaquin Basin



After: Hall, 1886;

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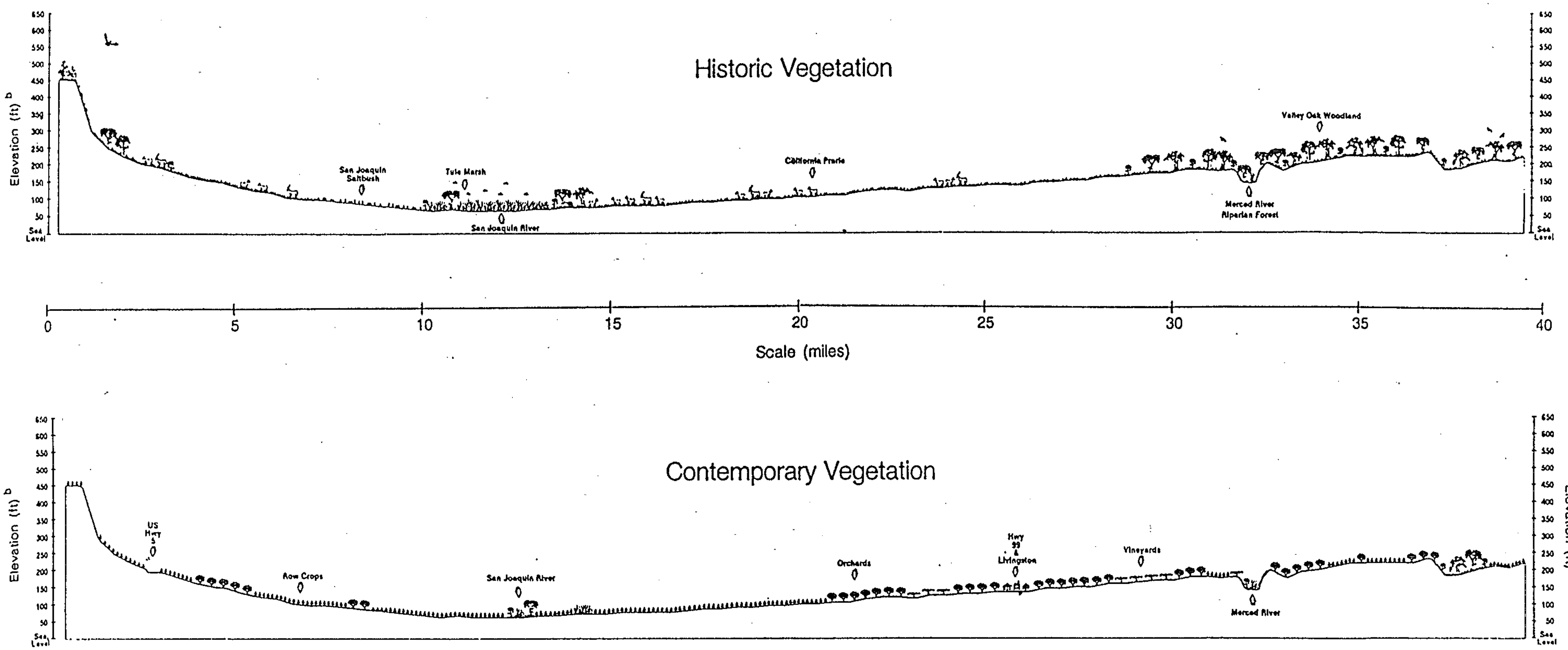
FIGURE 7. San Joaquin Basin Cross-section[ac]



[a] Historic vegetation compiled from: Kuchler, 1977; Piemsel and Lawson, 1937; Perkins in Smith, 1939; Preston, 1981. Historic hydrology compiled from: Hall, 1887; Goddard, 1857. Elevation and contemporary vegetation compiled from: USGS 7.5 minute series quadrangle maps: Kettleman City, 1981; Stratford SE, 1954; El Rico Ranch, 1954; Corcoran, 1954; Waukena, 1954; Paige, 1969; Tulare, 1969; Visalia, 1969; Exeter, 1969.

[b] Elevation is exagerated 50 times with respect to distance scale. Biota and structures represent distribution, but are not to scale.

[c] From near Crevison Peak, Stanislaus Co. to near Snelling, Merced Co.

TABLE 7

HISTORIC AND CURRENT STATUS OF SELECTED WILDLIFE HABITATS[a]

Habitat	State			Central Valley			San Joaquin Valley		
	Historic[b]	Current[b]	% Remaining	Historic[b]	Current[b]	% Remaining	Historic[b]	Current[b]	% Remaining
Wetlands	5,000,000[c]	459,000[d]	9%	1,500,000[e]-4,000,000[c]	281,000[f]	7-19%	1,093,000[g]	~85,274-~90,749[h]	8%
Riparian Forests[i]	---	---	---	1,600,000-2,000,000[e]	102,000[j]	5-6%	902,000[g]	~39,300[j,k]	4%
California Prairie	20,000,000[l]-22,000,000[m]	7,580[n]	<1%	---	---	---	4,444,000[g]	1,500[n]	<1%
San Joaquin Saltbush	1,172,000[g]	99,381[o]	8%	1,172,000[g]	99,381[o]	8%	1,172,000[g]	99,381[o]	8%

[a] Habitat figures are presented in acres. "---" indicates no data are available.

[b] Historic habitat figures represent habitat extent prior to European settlement (prior to the mid-1800's), unless otherwise noted. Current habitat acreages are for the mid-1970's to the present time, unless otherwise noted.

[c] USFWS, May 1978.

[d] Acreage presented is sum of coastal wetlands (USFWS, Feb 1979; USFWS, Nov 1989), and Central Valley wetlands (USFWS, Sep 1987). Total wetlands for the State probably exceed the acreage given because mountain and desert wetlands (acreage unknown) are not included.

[e] Warner and Hendrix, 1985.

[f] USFWS, Sep 1987.

[g] Acreages derived from figure 2-1, "Historic Hydrography and Natural Habitats of the San Joaquin Basin," and figure 2-2, "Historic Hydrography and Natural Habitats of the Tulare Basin," which were adapted from Hall (1886) and Kuchler (1977).

[h] Acreages from table 2-6, "Changes in Wetland Habitat Acreage: 1957-63 through 1986-89:" Does not include wetlands in the south Delta and Farmington-Escalon duck club areas; therefore, wetlands acreage presented should be viewed as conservative.

[i] Includes riparian forest and valley oak savanna habitat types.

[j] Adapted from data generated through photo-interpretation of 1977 aerial photographs (Katibah et al., 1980). Data were not available for all areas on the San Joaquin Valley floor; therefore, acreage estimate presented may be low. Conversely, current acreage has probable been reduced by suburban and/or other developments since 1977.

[k] Acreage of riparian forest on the San Joaquin Valley floor in 1977 was approximately 35,360 acres; acreage of valley oak savanna on the San Joaquin Valley floor in 1977 was approximately 3,933 acres (adapted from Katibah et al., 1980).

[l] Burcham, 1982.

[m] Dasmann, 1965.

[n] Current acreage represents remnants of native California prairie dominated by perennial bunchgrasses as of 1972 (Barry, 1972).

[o] Werschkull et al., 1984. Actual acreage may be higher because estimate based on San Joaquin saltbush habitat remaining in Tulare Basin only.

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the dynamic nature of topography and hydrology. This constant change ensures habitat diversity and, thus, wildlife diversity.

Riparian habitat can be classified into three community classes: gravel bar, low terrace, and high terrace. One of two vegetative communities develop on gravel bars: willow scrub or willow-cottonwood forest. Willow scrub vegetation pioneers gravel bars, cut banks, and other areas subject to seasonal flooding or high water levels, eventually becoming a dense thicket. Over time, willow thickets may evolve into willow-cottonwood forests as the saplings grow. Black willow, arroyo willow, and cottonwood are dominant, with alder, valley oak, and elderberry also present. Older stands typically have a shrub understory, and herbaceous vegetation may be sparse or dense.

Although the above communities may be present on some low terraces, mature cottonwood forest, mixed riparian herb/scrub, and alder-willow forests are the common plant communities that develop. These communities, higher in elevation than gravel bars, are still sensitive to flood plain water level fluctuations and high-flow events.

Mature cottonwood forests evolve from young willow-cottonwood forests and contain either a dense understory of herb-vine growth or a mid-story of black walnut, box elder, and willows. The mixed riparian herb/scrub community is located on riverbanks, berms, and terraces where disturbance from levee maintenance and farming practices prevents the development of mature forests. Plants include annual grasses, sedges, rushes, vines, shrubs, and saplings. Alder-willow forests develop in narrow bands where steep gravel, rock, or riprap banks extend to the shoreline (defined by sustained summer water levels).

High terrace communities develop from mature cottonwood forests as elevations increase and cottonwoods age, die, and are replaced by mid-story species. These communities are not usually subject to the effects of floodflows and are inundated only during peak storm events. Thus, they are more stable and attractive for development, which has made them one of the rarest plant communities in the San Joaquin Valley.

Wetlands. Wetlands refers to those nonriparian areas permanently or seasonally inundated by shallow water. Permanent wetlands are best represented by tule marshes and are typically covered with at least several inches of water for most of the year (SJVDP, 1990). Seasonal wetlands include wet meadows and vernal pools on lands which are inundated only part of the year. Characteristic species include common tule, cattail, sedges, and rushes. Tule marsh is the primary wetland community in the San Joaquin Valley. Vernal pools are another important wetland community and were once common throughout the California prairie. Vernal pools form in shallow depressions underlain by an impervious substrate (e.g., clays) and vary greatly in size from 10 feet across to a few hundred acres. They contain a unique assemblage of often endemic species, mostly native annuals.

As of 1989, only 281,000 acres of wetlands remained out of 4 million, a loss of more than 90 percent (Frayer, et al., 1989). Of the remaining Central Valley wetlands, approximately 80,000 acres are flooded in the San Joaquin Valley in an average year. Most are managed permanent and seasonal wetlands (i.e., duck clubs or wildlife refuges) (SJRMP, 1992). In addition, many vernal pools and some wet meadows remain. In recent years, seasonal wetlands have been forming in agricultural lands adjacent to mainstem levees during high riverflows.

Environmental Impacts. Table 8 summarizes potential impacts to vegetation from the various alternatives, including No-Action, as well as potential impacts to other resources.

No Action. Without the project, vegetation patterns in the San Joaquin Valley should not change significantly in the near future. The relative percentages of lands in various cover types (i.e., row crops, pasture, natural, etc.) and uses (agriculture, residential, etc.) should remain fairly constant. Some agricultural and natural lands will be converted to residential and commercial uses to accommodate the expected population increases, but this will not change the predominantly agricultural landscape of the valley. Natural areas should not decrease much as most of the expected growth is already planned for marginal agricultural lands adjacent to existing urban areas. In fact, continued conservation efforts could increase the amount of land in a natural or undeveloped state, especially in the Grasslands/Los Banos area.

In the long term, vegetation patterns could radically change if the salinity/agricultural drainage problem is not solved and/or the current 6-year drought continues. In either case, selected existing agricultural lands could be forced out of production and would likely revert to native grasslands and/or scrub/shrub habitats.

Riparian. Although efforts are being taken to reduce losses and restore the condition of existing riparian habitat, the decline in habitat area, quality, and diversity continues. Adjacent land uses, existing water management, and activities within riparian areas will result in future impacts to these ecosystems. Future growth and development will continue to convert riparian habitats, especially higher elevation areas, to other land uses. This trend should continue in the near future.

Without the project, flood events on the San Joaquin River would continue to erode certain riparian areas, causing a loss of mature woodlands and willow thickets. However, this would be

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TABLE 8.

Summary of Environmental Impacts of Alternative Plans

ALTERNATIVE	VEGETATION	WILDLIFE	FISHERIES	T & E SPECIES	WATER QUALITY
No Action (local O&M)	Losses: 154 riparian acres and 176 upland/agricultural acres. All losses temporary.	Likely adverse impacts on many species, especially riparian species.	Likely losses of riparian and SRA habitat below the Merced River would affect fish.	Listed species that favor riparian areas could be adversely affected.	Minor, temporary increased turbidity in the mainstem adjacent to the work areas would result.
Channel and Levee Modification	Losses: 611 riparian acres and 437 upland/ag. acres. Most losses temporary except for 121 acres of mature growth.	Habitat losses would likely cause declines for certain species, especially riparian.	Probable significant SRA habitat losses would likely cause declines in fish, especially anadromous species.	Listed riparian species such as VELB and Swainson's hawk are likely to be adversely affected.	Minor, temporary increased turbidity in the mainstem adjacent to the work areas would result, but on a larger scale.
Full Diversion Areas	Losses: 37 riparian acres and 190 upland/ag. acres. Only the riparian is permanently lost.	Possible impacts on upland and nesting species. Likely benefits to wetlands species such as waterfowl and wading birds.	Adverse impacts are unlikely. Possible benefits if April or May mainstem flows rise.	Listed upland species such as the San Joaquin kit fox and the leopard lizard potentially affected.	Possible adverse impacts from flushing of salts and other pollutants. Possible benefits with proper timing of releases.
Partial Diversion Areas	Losses: 20 riparian acres and 90 upland/ag acres. Only the riparian is permanently lost.	Similar to Full Diversion but with fewer possible impacts/benefits.	Similar to Full Diversion but with less potential impacts or benefits.	Similar to Full Diversion but with fewer potential effects.	Similar to Full Diversion but with fewer potential impacts and benefits.
Environmental Restoration with Flood Control	Losses: 600-6,420 upland/ag. acres. Gains: 600-5,580 wetland acres; 0-840 riparian acres.	Habitat increases would lead to big wildlife increases. Nesting and wintering birds should especially benefit. Upland species may suffer.	No adverse impacts are likely from most proposed work. Revegetation work along the mainstem would have great benefits.	Certain (riparian) species would benefit greatly. Others could be adversely affected.	Adverse impacts unlikely. Possible benefits from filtration by wetlands.

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NOTES FOR TABLE 8

1. The No-Action alternative assumes local levee districts will be allowed to remove some vegetation, but no sediment or mature growth, from within the floodway. Numbers are based on numbers from Table 1 and include 5 percent maintenance removal of vegetation. Brush and mature growth are assumed to be riparian vegetation.

2. The Channel and Levee Modification alternative assumes the following: initial vegetation and sediment removal areas will coincide; subsequent vegetation and sediment removal areas will not coincide; after initial removal, 5 percent of the initial vegetation removal acreage will be cleared every 5 years and 10 percent of the initial sediment removal acreage will have sediment removed every 5 years; 30 one and one half-acre staging areas and 30 two-acre dewatering areas will be required for the removal work; all staging and dewatering areas will be located on upland vegetation or agricultural land on the landside of project levees; all seepage repairs will take place on upland vegetation on the landside of levees. Again, numbers are based on Table 1.

3. Diversion alternatives assume that flooded acreage will be agricultural lands, native uplands, and wetlands and that agricultural lands will continue to be farmed or grazed. It is assumed that wetlands will not be affected and that the existing vegetation of the flooded acreage will not be changed due to the diversions.

4. Vegetation numbers in the Environmental Restoration with Flood Control alternative represent a range from completing only the smallest proposed project to all proposed projects.

offset somewhat by the creation of riparian habitat at sediment deposition areas, albeit at younger successional stages. Future flood events and their impact on farming costs could cause riverside agricultural fields to be abandoned, thus potentially increasing riparian habitat.

Expected future channel and levee maintenance activities (i.e., limited vegetation removal and structural repairs) by local levee districts will temporarily eliminate some riparian habitat and could prevent significant increases in riparian vegetation within the channel. Over 150 acres are likely to be adversely affected. This assumes that the levee districts will be allowed to remove vegetation as specified in Table 1. This figure also includes 5 percent maintenance removal over the 50 year life of the project.

It is unclear what the status of San Joaquin Valley riparian habitats will be in the long term. It appears that the long term trend will be preservation of remaining riparian areas as more people begin to recognize and accept the important natural values of these areas and conservation programs target these areas for restoration and/or preservation.

Wetlands. Without the project, nonriparian wetlands within the San Joaquin Valley will decrease in some areas and increase in others. Land acquisition by State and Federal agencies in the Grasslands/Los Banos area should result in a substantial increase in wetland acreage there, provided the agencies are able to carry out their land use objectives. Away from the Grasslands/Los Banos area, wetlands will probably decrease in both area and quality due to a lack of strong protection measures. In addition, many protected wetlands do not receive adequate water (quality and quantity) to operate at their full habitat value. Although efforts to reduce and/or eliminate wetland losses are being taken, the present trend is for the continued decline of wetlands (SJRMP, 1992).

Channel and Levee Modification. This alternative will result in the clearing of over 1,000 acres of vegetation within the San Joaquin River floodway, mostly riparian willow scrub and upland vegetation types. (see Table 8) Initial vegetation and sediment removal will eliminate 336 acres. The periodic vegetation and sediment removal program that will follow will destroy an additional 450 acres over the 50-year life of the project. Levee and erosion repair work will remove vegetation from 157 acres, almost all uplands or agricultural land. Affected areas should naturally revegetate during the life of the project and return to their former condition, except for the 121 acres of mature riparian vegetation which will in effect be permanently lost. All numbers in this section are based on information in Table 1, with the addition of estimates for the maintenance removal phase. Table 9 summarizes the vegetation impacts by activity.

Riparian. An estimated 611 acres of riparian habitat will be temporarily lost under this alternative, mostly immature willow thickets (brush in Table 1). This type of vegetation should replace itself over the life of the project. Approximately 121 acres of mature riparian vegetation (i.e., cottonwoods and oaks) will be destroyed. This vegetation type will not replace itself over the life of the project, resulting in permanent losses. Furthermore, some of the riparian habitat is likely to be Shaded Riverine Aquatic (SRA) an important habitat for aquatic species, especially anadromous fish. Any loss of SRA habitat will be a significant impact.

Initial sediment and vegetation removal will eliminate 219 acres and maintenance removal 390 more acres. (see Table 9) Levee repairs would probably eliminate only 2 acres. Almost all repair work is planned for the landside of the levees to avoid the riparian and SRA impacts that could be caused by waterside repair work. The majority of the acreage lost to sediment and vegetation removal will be lost temporarily, returning to its former condition over time. Levee repairs will likely eliminate seepage areas and the riparian vegetation that has developed there. It is not known how many acres will be affected. Wet areas on the landside of the levees that are filled will likely become upland habitat. However, new riparian areas will be created around the toe drains which should at least partially offset these losses.

Wetlands. Out-of-channel wetlands should not be much affected by this alternative as activities are mostly restricted to the San Joaquin River floodway. The exception is wetlands on the landside of the levees which have resulted from levee seepage. These wetlands will likely be eliminated by the levee repair work. It is not known how much of this type of wetland acreage exists. Creation of toe drains at the repair sites will create new linear wetlands, thus partially offsetting any wetlands losses.

Full Diversion Areas. This alternative should have minimal impacts to vegetation. (see Table 8) The water that will be diverted from the San Joaquin River and the flood control bypasses will be only temporarily stored off-stream (maximum 30 days) and on an infrequent basis (during storm events). Therefore, the vegetative composition of the storage areas should not change appreciably. It is possible that diversions, if frequent enough, may encourage some areas to revert to historic flood plain vegetation types. However, these unlikely vegetative changes to more natural flood plain conditions would probably be viewed as a positive change. Based on the specifications,

TABLE 9.

Vegetation Impacts from Channel and Levee Modification, by Activity

Activity	Upland/ Ag. Land Losses	Riparian Losses (Mature Growth)	TOTAL
Initial Removal[1]	117	219 (115)	336
Maintenance Removal[2]	60	390 (6)	450
Construction of Staging and Dewatering Areas[3]	105	0[4]	105
Seepage Repair	154	0[4]	154
Erosion Repair	1	2	3
TOTAL	437	611 (121)	1048

Notes:

All numbers are based on information from Table 1.

All vegetation losses will be temporary except for mature growth.

[1] This assumes sediment removal areas are within vegetation removal areas.

[2] Estimated at 5 percent of initial acreage for vegetation removal and 10 percent for sediment removal, every 5 years. This assumes that vegetation and sediment removal areas no longer coincide.

[3] Staging assumes thirty 1.5-acre sites, dewatering assumes thirty 2-acre sites, all located on uplands or agricultural lands.

[4] This assumes that no riparian vegetation exists at the landside levee repair work areas.

approximately 37 acres of vegetation will be permanently eliminated at the site of the concrete and metal water control/diversion structures. This is assumed to be riparian habitat. The construction of the low earthen berms will cover 190 acres of additional vegetation, assumed to be grassland or agricultural land. However, some trees and woody vegetation will likely be destroyed during construction of the berms. Grasses and other vegetation should naturally recur on the new berms, resulting in mostly temporary losses.

Riparian. Construction and placement of the water control/ diversion structures will necessitate the permanent removal of small areas of riparian vegetation, estimated at 37 acres. However, as a whole this alternative could benefit riparian habitat in the diversion storage areas since water will be flowing into historic sloughs and overflow channels more frequently than at present. Increased moisture should help riparian vegetation in and along these channels that are currently stressed from lack of historic seasonal flooding.

On the mainstem, storage of peak floodflows could affect downstream riparian communities by lowering seasonally high water levels and velocities. This could further disrupt natural successional patterns and exacerbate long-term adverse trends (i.e., loss of oaks on terraces). Gravel bars and terrace communities could be particularly affected.

Wetlands. The construction and placement of the water control/diversion structures should not adversely affect nonriparian wetlands since all structures will be located adjacent to streams and channels. Diversion of floodwaters should benefit wetlands within the off-stream storage areas due to increased frequency of seasonal flooding. Receiving water somewhat more consistently than at present should help maintain and possibly improve the functions and values of the wetlands. The storage of peak floodflows could deprive some wetlands along the mainstem of seasonally received water leading to the degradation and possible loss of some wetlands.

Partial Diversion Areas. Potential impacts to vegetation will be very similar to the Full Diversion Areas alternative; however, the area potentially affected will be much less. Again, sites within the diversion areas could experience changes in vegetative composition, although it is not likely. There will be fewer water control/diversion structures and less linear feet of berms; therefore, less vegetation will be lost. Less of the peak floodflows will be diverted, so there will be less chance for downstream vegetation along the mainstem to be affected.

Riparian. With fewer water control/diversion structures than full diversion, less riparian vegetation will be removed and permanently lost. Based on 18 structures, about 20 acres of habitat will be eliminated. There should still be significant benefits to riparian vegetation in the former flood plain, but they will be less than under full diversion since the total diversion storage area will be smaller and less water will be diverted. Fewer historic channels and sloughs will receive floodwaters. Potential adverse impacts to downstream riparian communities along the mainstem will be less likely as well.

Wetlands. Wetlands within the smaller diversion storage area will benefit as described in the Full Diversion Areas alternative. Of course, total benefits to wetlands will be less under this alternative since the diversion storage area is smaller.

Environmental Restoration with Flood Control. In general, this alternative has the most environmental benefits and the least potential adverse impacts to vegetation of all the alternatives. Environmental restoration projects would provide benefits by altering the vegetative communities on the affected lands to more natural conditions. Generally, upland vegetation (i.e., pasture, annual grassland) and abandoned agricultural lands on the former flood plain will be converted into new riparian areas and wetlands. The amount converted depends on how many of the individual projects are undertaken. The maximum could be approximately 6,420 acres of upland vegetation and/or agricultural land converted, while the minimum could be in the neighborhood of 500 acres. (see Table 8) Pasturelands and annual grasslands are relatively abundant in the study area and the loss of 500 to 6,000 acres of these types of vegetation should not be significant, at least locally. This is especially true when balanced against the gain of more valuable riparian areas and wetlands.

The diversion and temporary storage of floodwaters on the restoration areas would have incidental environmental benefits, such as providing a temporary water source. The floodwaters would not adversely affect these areas. However, the necessary diversion structures would affect riparian vegetation.

Riparian. New riparian areas would be created in the Grasslands/Los Banos area and/or along the mainstem San Joaquin River. The new amount could vary from a high of about 840 acres to a low of zero acres. Any additional riparian habitat in the study area would have many positive benefits to the basin environment, as described in pages 8 to 10. The environmental restoration proposals and floodwaters would have no impact to existing riparian areas. The structures for diverting floodwaters into the restoration areas would permanently eliminate approximately 10 acres of riparian vegetation. This is insignificant given the riparian benefits resulting from restoration.

Wetlands. New wetlands would be created in the Grasslands/Los Banos area. If all proposed projects are completed, 5,580 new wetland acres would be gained. However, as few as 600 new wetland acres would result from the smallest restoration proposal. Any increase in wetlands within the basin would be a great benefit to the environment as described in pages 8 to 10. Waterfowl would particularly benefit. Existing wetlands would not be affected by the environmental restoration projects or the floodwaters and diversion structures.

Mitigation. Project mitigation requirements would be determined during feasibility studies using the Habitat Evaluation Procedures (HEP) developed by the FWS. The HEP quantifies project-induced losses and gains in habitat units from existing and future without-project conditions. The HEP is based on evaluation species selected to represent habitat types in the area and the relative value of the habitat types. Information generated by the HEP would be used to prepare an incremental analysis and determine the capabilities of alternative mitigation areas for cost-effective mitigation.

For mitigation purposes, the FWS divides fish and wildlife resources into four categories and assigns values to each one. Value determinations are based on the importance of the habitat types found in the study area to the evaluation species and the relative scarcity of the habitat types on a national or regional basis. Values range from those considered to be unique or irreplaceable to those believed to be of relatively low value to fish and wildlife. The FWS considers riparian habitat, wetlands, and shaded riverine aquatic (SRA) habitat to be scarce and/or valuable in the study area and advocates no loss or net loss of existing habitat value or acreage.

Given the above information, mitigation for impacts to vegetation would vary considerably under each alternative. The Operation and Maintenance alternative would necessitate a large amount of mitigation since hundreds of acres of riparian vegetation and some wetlands would be destroyed or adversely affected. The FWS goal is no net loss of in-kind habitat value for these habitat types. Therefore, these habitats and their values would need to be replaced in greater-than-equal amounts to account for annual losses. In addition, some SRA habitat is likely to be eliminated. Since the FWS goal for this is no loss of existing habitat value, this loss cannot be mitigated. The diversion alternatives would require significantly less mitigation acreage since much less vegetation will be affected and some may in fact benefit. In addition, SRA habitat could probably be entirely avoided. The other flood control alternatives would fall somewhere between these two extremes. The environmental restoration alternative would possibly require no mitigation since a trade-off of lost upland vegetation for new riparian areas and wetlands would likely be acceptable.

WILDLIFE

Existing Conditions. Despite the loss of significant habitat areas, including critical riparian habitat, the San Joaquin Valley continues to support a large number of wildlife species and individuals. The plant communities found along the San Joaquin River and its tributaries remain an integral part of the total San Joaquin Valley ecosystem upon which fish and wildlife resources depend.

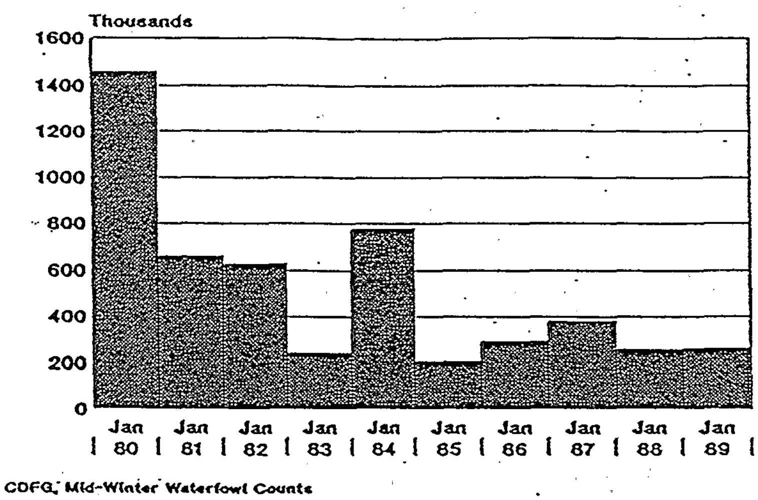
Upland game species in the study area include California quail, ring-necked pheasant, mourning dove, band-tailed pigeon, Audubon cottontail, brush rabbit, black-tailed jackrabbit, and gray squirrel. Furbearers are represented by coyote, red and gray foxes, bobcat, raccoon, opossum, spotted and striped skunk, badger, muskrat, weasel, and beaver.

About 200 species of birds are known to inhabit the project area as resident or seasonal visitors, many in riparian areas. This habitat provides valuable breeding, nesting, and feeding areas for resident birds. Individual stands of high-value riparian woodland often have 10 to 50 breeding bird species; most have between 20 and 34. Population densities of birds breeding in riparian areas generally fall between 40 to 900 pairs per 40 hectares. Birds using riparian ecosystems can be categorized into at least four groups based on their seasonal occurrence: (1) summer (breeding) residents, (2) winter residents, (3) transients (migratory), and (4) permanent residents (non-migratory). As a result, bird populations are distinctly different from season to season.

The San Joaquin River system is part of the Pacific Flyway and provides important resting and feeding areas for migratory waterfowl, shorebirds, and other water-associated birds. Historically, San Joaquin Basin wetlands were flooded nearly every year during the winter and spring by natural overflow from the San Joaquin River and tributaries. Waterfowl use of the San Joaquin Basin is extensive in the study area, on State and Federal wetlands and on waterfowl hunting clubs, particularly when flooding occurs. The wetlands and agricultural lands provide important food and resting areas for waterfowl. Figure 8 shows waterfowl population data for the San Joaquin Basin.

Many species of waterfowl frequent wetland habitat, such as the mallard, pintail, cinnamon teal, and American widgeon. Shorebirds and wading birds include the great blue heron, great and snowy egrets, sandhill crane, American avocet, and black-necked stilt. Egret and heron rookeries are found at selected locations. Raptors include the golden eagle, northern harrier, red-tailed hawk, short-eared and barn owls, and turkey vulture. Passerine species largely associated with the study area include

FIGURE 8. Mid-Winter Waterfowl Totals 1980-89
San Joaquin Valley



the Brewer's blackbird, scrub jay, red-shafted flicker, common crow, yellow-billed magpie, and the tree, rough-winged, and cliff swallow. Reptiles and amphibians include the aquatic garter snake, common garter and gopher snakes, the western fence and California legless lizards, bullfrogs, and the Pacific pond turtle. The value of riparian vegetation to wildlife far exceeds the value of an equivalent acreage of nonriparian woody cover because of its linear distribution and edge effect. Naturalists and wildlife managers recognize that the numbers and types of wildlife species in a given habitat relate directly to the amount of interface between diverse habitat types. The amount of suitable cover and diversity of habitat is a major factor in determining the productivity and carrying capacity of the San Joaquin-Kings River North system.

Environmental Impacts.

No Action. In general, biological diversity (number of species) and wildlife populations of the San Joaquin Valley will continue to decline without the project as human activities continue to adversely affect wildlife, primarily through the loss of habitat quantity and quality. However, if significant land can be converted to a natural condition, wildlife should benefit, especially if more riparian and wetland acreage is obtained.

As for the mainstem river corridor, wildlife would continue to be subject to periodic stress from floods due to lack of escape routes and destinations. Any future channel maintenance activities would also adversely affect wildlife by degrading or removing important riparian and SRA habitat. Some of this adverse impact could be offset if flood prone riverside farmlands are abandoned and become new riparian areas.

Channel and Levee Modification. The initial clearing of 336 acres of mostly riparian habitat within the San Joaquin River floodway and the periodic removal of vegetation from 450 acres in the future will adversely affect wildlife species that inhabit or use the river corridor. Total nesting and feeding areas and cover will decline and existing habitat will be further fragmented. Levee repair work will also adversely affect wildlife habitats, primarily uplands. Migratory and riparian dependent species will be especially affected by this alternative. Any losses of SRA cover could have significant adverse impacts on raptors, songbirds, and aquatic mammals. Construction during nesting season could reduce the nesting success of many species, such as raptors. In sum, wildlife populations associated with the mainstem corridor would be expected to decline further under this alternative.

Full Diversion Areas. This alternative will have varying impacts on wildlife. Some minor habitat will be lost due to construction of the berms and water control/diversion structures, but the loss should not be significant since abundant grasslands or agricultural land will mostly be affected. Certain wildlife species, particularly upland species, may be adversely affected in the off-stream storage areas during diversions. Temporary losses of feeding and nesting areas will result. If diversions take place during nesting periods, reproduction losses could be significant that year. Moreover, if the vegetative composition of portions of the storage areas changes, some upland species may be permanently displaced. Although very unlikely, this has the potential to adversely affect a large number of species.

Wildlife species that favor wetlands and riparian habitats should benefit greatly from the periodic flooding, increased flows in historic overflow channels, temporary wetlands, and increased moisture levels in the diversion storage areas. For example, a significant amount of wintering waterfowl habitat will be created during the diversion events.

Partial Diversion Areas. This alternative will have potential adverse impacts and benefits to wildlife very similar to the Full Diversion Areas alternative, only at a lesser scale. Basically, any adverse effects on upland species would be slightly lowered, and there would be less benefits to species that favor riparian areas and wetlands.

Environmental Restoration with Flood Control. The environmental restoration proposals would have tremendous benefits for many wildlife species, particularly waterfowl, wading birds, shorebirds, and passerine birds. Table 10 presents rough estimates of potential wildlife benefits, based on the proposed habitat improvements/increases and observations of similar areas on local refuges, provided by local biologists. A HEP analysis of the restoration areas is needed to arrive at more accurate predictions.

If all plans are completed, large increases in permanent, migratory, and wintering habitat availability will result. Almost 5 million additional annual waterfowl days of use would be expected, including the capacity to host over 500,000 additional wintering ducks and geese (Personal Communications with Les Howard, Joel Miller, and Tim Poole). Nesting habitat should increase dramatically as well, resulting in almost 10,000 more nesting pairs of waterfowl and thousands of young. New habitat areas will have the potential to house approximately 3,000 new pairs of wading birds such as herons, bitterns, egrets, ibis, and stilts. Shorebirds should also experience great increases in usable habitat, almost 2 million days of use annually (with waders). Sandhill crane use of these lands should also increase dramatically to the neighborhood of 40,000 to 50,000 additional annual days of use. Raptors such as eagles, falcons, and hawks should increase their presence with new feeding and nesting areas; China Island alone could support two or three more nesting

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TABLE 10. Estimated Fish and Wildlife Benefits from Environmental Restoration Projects.[1]

ITEM	CHINA ISLAND	ARENA PLAINS	GRASS-LANDS	RM 63-70	TOTAL
New wetlands (acres)	1,180	600	3,800	0	5,580
New riparian habitat (acres)	580	0	90	170[2]	840
Waterfowl (days of use/year)	3,495,000	200,000	1,115,000	minimal increase	4,810,000+
Waterfowl (add. nesting pairs)	670	120	9,000	minimal increase	9,790
Waders and shorebirds (days of use/yr.)	1,262,000	300,000	405,000	unknown increase	1,967,000+
Raptors (days of use/yr.)	46,000	1,200	7,500	unknown increase	54,700+
Passerine birds (days of use/yr.)	10 million	150,000	1,310,000	unknown increase	11,460,000
Aquatic Mammals (days of use/yr.)	82,000	unknown increase	unknown increase	unknown increase	82,000+
Fish (new habitat in acres)	110	0	0	large increase	110+
Other wildlife (days of use/yr.)	730,000	unknown increase	unknown increase	unknown increase	730,000+

[1] Numbers are based on observations and data recorded at local wildlife refuges and were provided by local biologists.

[2] Includes 19,000 linear feet of new shaded riverine aquatic habitat. This is expected to become established by the end of project life (50 yrs.).

hawks, for example. Finally, many other wildlife species, from songbirds to reptiles (including threatened and endangered species), would benefit directly and indirectly.

The temporary storage of floodwaters would not adversely affect wildlife. Diversions would be coordinated with the land managers to avoid conflicts with operations and potential impacts on nesting species. Again, diverted floodwaters would likely have incidental environmental benefits. The diversion structures would eliminate small areas of wildlife habitat, but this loss will be more than offset by the benefits.

Mitigation. Since impacts to wildlife are directly related to the loss of habitat resulting from the project, mitigation of impacts to vegetation (habitat) will mitigate for impacts to wildlife. It is assumed that most wildlife will return to areas that revegetate. The Corps would develop and implement a mitigation plan based on FWS recommendations, a HEP analysis, and an incremental analysis to be conducted during feasibility studies. Other wildlife mitigation would consist of identifying and avoiding sensitive habitat areas near construction sites and confining construction activities around nesting raptors during the nesting season.

FISHERIES

Existing Conditions. The San Joaquin Valley previously supported a productive fishery of both resident and anadromous fishes, including Sacramento and tule perch, Sacramento sucker, thick-tailed chub, Sacramento squawfish, hardhead, Sacramento blackfish, hitch, and Sacramento splittail. Rainbow trout and anadromous species, including white sturgeon, steelhead, and chinook salmon, were also present in the San Joaquin River and tributaries as far south as the Kings River. These species are still present but in lesser numbers. Introduced warmwater species are now the most abundant fish.

Prior to major water developments, the San Joaquin River system supported both a fall-run and a spring-run of chinook salmon. A smaller population of winter-run salmon may have used the northern east-side tributaries to the San Joaquin. The spring-run population was the most abundant race of chinook salmon in the San Joaquin Valley. Total runs exceeded 100,000 fish annually and probably exceeded 200,000 in peak years (USFWS, 1992). Spring-run chinook salmon in the San Joaquin were essentially extirpated as a result of construction and operation of Friant Dam. Spring-runs on the other tributaries had been eliminated due to dam construction prior to and shortly after 1900.

As a whole, chinook salmon production in the San Joaquin River drainage has declined by over 85 percent since the 1940's (SJVDP, 1990). Due primarily to artificial propagation, fall-run fish continue to exist in five major east-side tributaries to the San Joaquin River (the Merced, Tuolumne, Stanislaus, Mokelumne, and Cosumnes Rivers). Occasionally, fall-run chinook salmon also ascend the Calaveras River. In addition, the Calaveras River has supported a small run of winter-run chinook salmon; however, the status of this population is currently unknown. Since the completion of Friant Dam, chinook salmon have appeared in the upper mainstem of the San Joaquin River only in extremely wet years and have successfully spawned only once in the Kings River, during the flood year of 1969. Estimated numbers of spawning adult salmon that returned to the major San Joaquin River tributaries from 1940 through 1989 are presented in Table 11. Recent spawning populations have been extremely low. The 1990-91 average fall-run chinook salmon escapement for the system was only 900 fish (SJRMP, 1992). The cumulative effects of the drought, water developments, fish harvest, poor water quality, water diversions, and habitat deterioration have taken a serious toll.

There is presently no minimum instream flow requirement for the mainstem San Joaquin River below Friant Dam. The US Bureau of Reclamation does release water to meet the demands of downstream water rights holders, but the river is essentially dry (except for some agricultural return flow) until it receives tributary inflow from Bear Creek, Salt and Mud Sloughs, and the Merced River some 90 miles downstream of Friant Dam. As a result, the mainstem above the mouth of the Merced River no longer supports a fishery. The mainstem below the Merced River, however, remains an essential migratory corridor for salmon and steelhead adults moving into the tributaries to spawn in the fall and for juveniles moving out in the spring. So while there is no mainstem fishery per se, the issue of instream flows is a crucial one. In addition, the question of restoration of the mainstem fishery remains a point of contention between fish and wildlife advocates and the water development community.

In sum, the San Joaquin River above the confluence of the Merced River has no significant fishery, and the San Joaquin River below the Merced River is dominated by introduced warmwater fish species. Common species include green sunfish, bluegill, redear sunfish, largemouth bass, black crappie, threadfin shad, common carp, Sacramento blackfish, white catfish, black bullhead, brown bullhead, and mosquitofish. Remnant populations of native fish species continue to survive in the mainstem, and anadromous species use the mainstem as a migration corridor to move to and from east side tributaries. Fishery managers are working to increase fall-run chinook salmon and have produced a draft action plan. A list of fish known to occur in the San Joaquin River

TABLE 11.

CHINOOK SALMON SPAWNING ESCAPEMENT ESTIMATES: 1940-1989[a]

Year	San Joaquin River	Merced River	Tuolumne River	Stanislaus River	Mokelumne River	Cosumnes River
1940[b]	---	1,000[c]	122,000	3,000[c]	5,000[c]	---
1941	---	1,000[c]	27,000[c]	1,000[c]	12,000[c]	1,000[c]
1942	---	---	44,000	---	12,000[c]	---
1943	35,000	---	---	---	---	---
1944	5,000	---	130,000	---	---	---
1945	56,000	---	---	---	6,000	---
1946	30,000	---	61,000	---	---	---
1947	6,000	---	50,000	13,000	---	---
1948	2,000	---	40,000	15,000	<500	---
1949	---	---	30,000	8,000	1,000	---
1950	0	---	---	---	---	---
1951	0	---	3,000	4,000	2,000	---
1952	0	---	10,000	10,000	2,000	---
1953	0	<500	45,000	35,000	2,000	2,000
1954	0	4,000	40,000	22,000	4,000	5,000
1955	0	---	20,000	7,000	2,000	2,000
1956	0	0[d]	6,000	5,000	<500	1,000
1957	0	400[d]	8,000	4,000	2,000	1,000
1958	0	500[d]	32,000	6,000	7,000	1,000
1959	0	400[d]	46,000	4,000	2,000	0[d]
1960[d]	0	400	45,000	8,000	2,000	1,000
1961	0	50	500	2,000	100	---
1962	0	60	200	300	200	1,000
1963	0	20	100	200	500	1,000
1964[e]	0	40	2,000	4,000	2,000	2,000
1965	0	90	3,000	2,000	1,300	800
1966	0	40	5,000	3,000	700	600
1967	0	600	7,000	12,000	3,000	500
1968	0	500	9,000	6,000	1,700	1,500
1969	0	600	32,000	12,000	3,000	4,000
1970	0	5,000	18,000	9,000	5,000	600
1971	0	4,000	22,000	14,000	5,000	500
1972	0	3,000	5,000	4,000	1,100	1,600
1973	0	1,100	2,000	1,200	3,000	900
1974	0	2,000	1,100	800	1,400	300
1975	0	2,400	1,600	1,200	1,900	700
1976	0	1,900	1,700	600	500	0
1977	0	400	400	0	300	0
1978	0	600	1,300	50	1,100	100
1979	0	2,100	1,200	100	1,500	200
1980	0	2,800	500	100	3,200	200
1981	0	10,400	14,300	1,000	5,000	---
1982	0	3,000	7,000	---	9,000	---
1983	0	18,200	14,800	500	15,900	200
1984	0	34,000	13,700	12,000	6,000	1,000
1985	0	16,100	40,300	13,300	7,700	200
1986	0	6,200	7,300	5,900	5,000	---
1987	0	3,900	14,800	6,300	1,600	0
1988[f]	0	3,200	6,300	12,300	500	100
1989	0	200	1,600	1,400	200	100

a All fall-run fish. "---" indicates no data are or were available.
b Unless otherwise noted, data for 1940-1959 from: Fry, 1961.
c Escapement estimate based on incomplete count.
d Data for 1960-1963 and where noted from: Fry and Petrovich, 1970.
e Data for 1964-1987 from: Reavis, (in prep.).
f Data for 1988-1989 are preliminary counts from: pers. comm., Jul 15, 1990, T.H. Richardson, Fish and Wildlife Biologist, USFWS, Sacramento, CA.

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system within the project area is presented in Appendix A of Attachment 1.

Environmental Impacts.

No Action. Anadromous and other native fish of the San Joaquin system are likely to continue to decline without the project. Chronic poor habitat conditions (water quality, water quantity, streamside vegetation) coupled with the current drought threaten the long-term existence of many native fish species, especially migratory fish. Fall-run chinook salmon could increase if the action plan is implemented. Any future channel maintenance activities would likely temporarily increase turbidity and disturb chemical and physical aquatic habitat (e.g., lower dissolved oxygen) in the work areas. Some riparian and SRA habitat would also be eliminated. These habitat changes or losses would adversely affect fish in the system.

Channel and Levee Modification. Large-scale vegetation and sediment removal will temporarily increase turbidity in the mainstem in the area of the work sites and likely cause aquatic habitat disturbances and adverse impacts as mentioned above. In addition, significant losses of riparian and SRA habitat would adversely affect anadromous and resident fish, largely through reduction of cover and food sources. If levee repairs are limited to the landside, there should be little or no effect on fish from that activity.

Full Diversion Areas. At present, there should be only minor impacts to fish from this alternative. Water control/diversion structures will not interfere with anadromous fish migration or potentially affect those species since they will all be upstream from the mouth of the Merced River. This would change if anadromous fish were restored to the mainstem above the Merced River. Construction of the structures could temporarily affect or possibly eliminate some warmwater fish habitat, although very little significant habitat exists. Some warmwater fish species could be diverted with the floodwaters, but this should also not be significant.

Storing and slowly releasing floodwater may aid the spring migration of juvenile salmonids downstream to the Delta and Pacific Ocean, depending on the timing of diversions and releases. If this alternative results in higher April and May flows in the mainstem, juvenile salmon would benefit. In fact, augmented spring flows is an objective of SJRMP's Draft Action Plan for Fall-Run Chinook Salmon. The fall migration of adult salmon into the lower tributaries should not be affected since potential flood events will occur after the upstream migration period is over. The altered hydrology of the mainstem and its potential effects on salmon will need to be studied.

Partial Diversion Areas. This alternative has potential adverse impacts and benefits to fish very similar to the Full Diversion Areas alternative, but at a reduced scale.

Environmental Restoration with Flood Control. The restoration of riparian areas and wetlands in the Grasslands/Los Banos area should not significantly affect fish in the San Joaquin system. Riparian revegetation along the mainstem would be of great benefit to salmon, especially out-migrating juveniles. The mainstem is a critical migration route. Additional riparian vegetation and SRA habitat would increase near-shore shading, food production (insects), and organic inputs to the river. This could result in increases in numbers of salmon through higher survival rates of juveniles. In the San Joaquin River, the abundance of fall-run adult salmon is directly related to outmigration conditions in the April-May period (Lowdermilk, Personal Communication). Temperature is one of the key factors, and the reach of the mainstem below the Stanislaus River has a high temperature problem. Increased SRA habitat has been shown to lower instream temperatures.

Potential adverse impacts and benefits of the diversion of floodwaters would be similar to those discussed under the Full and Partial Diversion alternatives above.

Mitigation. Potential measures would include avoiding all in-channel construction during anadromous fish migration periods, especially the juvenile outmigration; controlling turbidity and the introduction of suspended sediments into the water column; locating project features and construction areas in such a way as to avoid destroying SRA habitat; and creating or enhancing fish habitat along the mainstem to replace the values that are lost. Again, a HEP analysis will help quantify habitat values lost and replacement requirements. It is anticipated that creation of instream cover and overhanging vegetation would be recommended.

THREATENED AND ENDANGERED SPECIES

Existing Conditions. According to a list supplied by the U.S. Fish and Wildlife Service on May 15, 1992 (Attachment 2), there are 10 Federally listed threatened and endangered species that may occur in the study area. Two additional species (the giant garter snake and the western snowy plover, coastal population) have been proposed for listing. Furthermore, 48 candidate species may occur within the study area, 29 of them plants.

Among the Federally listed species are three birds, the bald eagle, American peregrine falcon, and Aleutian Canada goose, all of which winter in the San Joaquin Valley. The Grasslands/Los Banos area typically contains a large number of wintering geese. The coastal population of the western snowy plover (proposed for

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listing) nests only along the coast and is distinct from interior snowy plovers. The coastal population is not likely to be present in the San Joaquin Valley.

Both Federally listed mammal species have a documented presence within the study area. The Fresno kangaroo rat occupies at least a 400-acre parcel within 857 acres of Federally designated critical habitat west of the town of Kerman in Fresno County. The San Joaquin kit fox is known to occur in 11 counties, including parts of Fresno, Merced, and San Joaquin Counties.

The two remaining animal species listed are thought to occur in the San Joaquin Valley. The valley elderberry longhorn beetle is a likely resident of riparian communities along the lower San Joaquin River. The blunt-nosed leopard lizard occurs in scattered patches of undeveloped land in Merced, Madera, Fresno, and Kings Counties within the San Joaquin Valley. The giant garter snake (proposed for listing) probably inhabits freshwater marshes, low-gradient streams, drainage canals, and irrigation ditches in the San Joaquin Valley.

The three plants on the Federal list, California jewelflower, Hoover's wooly-star, and palmate-bracted birds-beak, all formerly occurred in the San Joaquin Valley and may still be present in limited numbers.

In addition to the Federally listed species, several State-listed species are known to occur within the study area. State threatened species are the Swainson's hawk, the San Joaquin antelope squirrel, the giant garter snake, and the bank swallow. State endangered species are the western yellow-billed cuckoo, delta button celery, Ferris' birds beak, and Colusa grass. Most of theses species are associated with riparian areas and wetlands.

Environmental Impacts.

No Action. This alternative could have a significant adverse effect on species of concern through the expected future channel maintenance activities. Adverse effects would be due to the reduction of streamside habitat. For example, the valley elderberry longhorn beetle would suffer if maintenance removed elderberry plants. In general, if present trends continue, the existence of listed species will become more precarious, most candidate species will become threatened or endangered, and new species will be proposed for listing. Impacts to remaining wildlife habitats, including increased encroachment, will largely be responsible. If habitat conservation plans for listed species can be developed and implemented, species of concern could stabilize, or even increase.

Channel and Levee Modification. This alternative has the potential to adversely affect certain listed and proposed species. Again, the valley elderberry longhorn beetle could be adversely affected if elderberries are removed. Other listed and proposed species associated with riparian areas, such as the giant garter snake, would likely be affected.

Full Diversion Areas. Most listed species should not be significantly affected by this alternative. There may be some minor, indirect impacts due to small changes in habitats. Those species that favor riparian and wetland habitats should benefit from increased seasonal flooding in the storage areas. Conversely, listed species that favor upland habitats could be adversely affected within the storage areas. These species include the San Joaquin kit fox and the blunt-nosed leopard lizard. They will likely experience a temporary loss of feeding and nesting areas. However, most individuals should be able to escape to higher, dry locations during the diversions. If the vegetative composition of portions of the storage areas is changed, listed upland species could experience a significant loss of habitat. In addition, upland plants could be displaced by both berm construction and the increased flooding of the storage areas.

Partial Diversion Areas. This alternative has less of a potential effect on listed and proposed species. Any adverse impacts or benefits would be similar to those discussed under the Full Diversion Areas alternative.

Environmental Restoration with Flood Control. Under this alternative, species of concern that favor riparian and wetlands areas will benefit from the creation of new areas of these habitat types. These species include the giant garter snake, Aleutian Canada goose, and the valley elderberry longhorn beetle. Species that depend on upland habitats and/or marginal agricultural lands will experience a slightly decreased habitat area. Habitat losses will be extremely localized and, given the relatively large quantity of these habitats in the study area, should not be significant.

Potential adverse impacts and benefits of the diversion of floodwaters would be similar to those discussed under Full and Partial Diversion Areas above.

Mitigation. During feasibility studies, the Corps will request a current list of threatened and endangered species from the FWS and obtain a list of State-protected species from the State Department of Fish and Game. Biological surveys and data reports will be completed as necessary, and the Corps will prepare a biological assessment for the listed species and describe any potential adverse impacts. Formal consultation with FWS would be conducted if necessary and as required under Section 7 of the

Endangered Species Act. Formal consultation would identify appropriate mitigation measures. The Corps may seek to expedite the process by preparing or participating in Habitat Conservation Plans with local agencies and organizations.

WATER QUALITY

Existing Conditions. Water quality in the San Joaquin Valley varies considerably and is greatly influenced by agricultural practices. Variations in water quality parameters reflect input and dilutions from agricultural drainwater, ground water, and industrial and municipal water uses. In addition, water diversions affect instream water quality by lowering the dilution capability of the streams.

Surface and ground water on the valley floor is generally of poor quality, primarily due to irrigation drainwater which contains many contaminants and suspended solids. Westside tributaries and the mainstem San Joaquin River below Bear Creek are particularly poor in quality. The mainstem river and some tributaries function as a drain for the valley's irrigation drainage and industrial and municipal effluent. Thus, water quality decreases moving downstream as return flows increase and concentrate. During summer months and low streamflow periods (dry years), these return flows make up virtually the entire flow in portions of the lower river and certain tributaries.

Irrigation drainwater in the San Joaquin Valley has been shown to contain elevated levels of selenium, boron, various heavy metals, and pesticides. These contaminants and high levels of suspended solids (i.e., salts) are present in many of the sloughs, creeks, ground water aquifers, and some wetlands on the valley floor, in addition to the mainstem river, because of drainage practices. Salt Slough, Mud Slough North, and several canals in the Grasslands area are particularly affected by contaminants and suspended solids. These sloughs are used to carry drainage water from westside agricultural lands with high levels of selenium, boron, and other trace elements to the San Joaquin River. Data indicate that these sloughs exceed State standards for selenium (SJVDP, 1990). Other westside tributaries exceed Federal water quality criteria for certain pesticides.

As for the San Joaquin River, the reach below the confluence of Salt and Mud Sloughs shows the highest levels of contaminants and total dissolved solids (TDS). The mainstem San Joaquin River generally meets water quality criteria, although it has four times the selenium levels of other rivers in the world and higher pesticide concentrations than most other rivers in the United States (SJVDP, 1990). High levels of the contaminants contained in irrigation drainwater have been proven responsible for causing death and deformity in fish and wildlife. High TDS levels are also detrimental to fish and wildlife.

Industrial and municipal effluent introduces nutrients, toxic compounds, heavy metals, and other contaminants into the mainstem and some tributaries. Urban areas on the eastside of the valley are the primary source of these inputs. Although this type of pollution is not nearly as significant as irrigation drainwater in the valley, it still adversely affects fish and wildlife. For example, nutrient inputs often lower dissolved oxygen to levels below that which is conducive to fish.

Directly below the major dams the mainstem San Joaquin River and tributaries have relatively good water quality due to reservoir releases. Temperatures, turbidity, nutrients, and alkalinity are low and dissolved oxygen high. Substantial instream flows are usually present, and agricultural drainwater and industrial and municipal wastewater inputs are minimal. Water quality degrades as it moves downstream, but the quality of most eastside tributaries is much better than that of the mainstem and sloughs of the valley floor.

Environmental Impacts.

No Action. The quality of the water resources of the San Joaquin valley should remain relatively constant without the project. Contaminated irrigation drainage water will continue to adversely affect surface and ground water. Water quality could significantly improve in the future through the efforts of SJRMP and USBR and if the agricultural drainage problem is addressed. Expected future channel maintenance activities would cause temporary, local increases in turbidity and suspended sediments in the mainstem.

Channel and Levee Modification. Vegetation and sediment removal would cause temporary, local increases in turbidity and suspended sediments in the mainstem. Past sampling of mainstem sediments suggests that there will be no significant release of contaminants into the water column due to disturbance from removal of vegetation and sediment. Levee repairs will not affect water quality as long as the repairs are made on the landside.

Full Diversion Areas. This alternative has the potential to both adversely affect mainstem water quality and to benefit basin water quality. Diversion and temporary storage of water will likely leach some salts, trace elements, and other contaminants from soils in the storage areas and convey them into the mainstem when the floodwater is released. Existing levels of these pollutants within the soils of the storage areas and the timing of releases in regard to mainstem flows will largely determine if impacts to water quality are adverse. If instream flows are sufficiently high, adverse impacts should not occur due to dilution. This should be the case since diversions and releases will take place during high-flow events. In addition, past land use of the storage areas suggests that contaminated soils will not be present.

The storage and slow release of peak floodflows could benefit overall basin water quality if storage releases can be coordinated with releases of poor quality irrigation drainage water. In this case stored floodwaters could be used to dilute contaminant levels in the mainstem.

Partial Diversion Areas. Potential adverse impacts and benefits to water quality are similar to the Full Diversion Areas alternative, but at reduced levels.

Environmental Restoration with Flood Control. Restoration as proposed should have no adverse effect on water quality. Although contaminants could be flushed out of new wetland areas, the areas are not extensive enough to adversely affect surface water quality. The new riparian areas and wetlands, if established, could improve surface and ground water quality through their filtering and recharge capabilities.

Potential adverse impacts and benefits of the diversion of floodwaters would be similar to those discussed under Full and Partial Diversion Areas above.

Mitigation. Construction methods will be employed that control turbidity and the introduction of suspended sediments into the mainstem during vegetation and sediment removal. The Corps will seek to coordinate the timing of discharges so as not to effect mainstem water quality and will attempt to time discharges to improve basin water quality. Plans will be coordinated with the State Water Quality Control Board, and all necessary permits will be obtained.

CULTURAL RESOURCES

Cultural resources or historic properties include buildings, structures, objects, sites, districts, and archeological resources associated with historic or prehistoric human activity which are listed, or are eligible for listing in the National Register of Historic Places. Such properties may be significant for their historic, architectural, scientific, or other cultural values and may be of national, State, or local significance.

Federal agencies are required to consider cultural resources during project planning and implementation. A number of laws and regulations guide this process. Principal among these is the National Historic Preservation Act of 1966, as amended (Public

Law 95-515). In particular, the Section 106 review process of this act and implementing regulations (36 CFR 800) guide the manner in which this law is carried out.

Existing Conditions.

Archeological Background

The northern San Joaquin Valley has not been the subject of an exhaustive archeological investigation. Instead, several smaller surveys have been conducted over the years. In addition, some widespread nonintensive surveys conducted prior to 1940, provided a general picture of the archeological site potential in the region.

The Central California Taxonomic System grew out of work done in the Delta region, which established a local sequence of cultural change in three horizons (Lillard, Heizer and Fenenga, 1939). This revolutionized California archeology, which had previously believed that the State's prehistory was static. In 1954, Beardsley created the Central California Taxonomic System using the previous work and based on McKern's 1939 Midwestern system. Archeologists now recognize that these sequences, such as the Delta region, are applicable only on the local level. Reevaluating the three-horizon model in the 1970's resulted in a pattern-aspect scheme replacing the horizon-district-facies scheme for some locations. Despite attempts to establish a new scheme, the cultural sequence for the study area remains based on the horizon-district-facies scheme due to a lack of data (Beardsley, 1954; Moratto 1984).

Ethnographical Background

The entire study area lies within the traditional territory occupied by the Yokuts Indians. The Yokuts were a large, diverse group who spoke the Yokutsan language. This language has three major divisions: (1) Buena Vista Division; (2) Foothill Division; and (3) Valley Division. The project area falls within the Valley Division. The Valley Division consisted of three major groups: Northern Foothills, Northern Valley, and Southern Valley. This project lies within the territory of the Northern Valley group, with a small portion in the territory of the Northern Foothills group (Wallace, 1978).

The Northern Valley Yokuts, like most California Indian groups, relied on acorns for subsistence. Fishing was also an important activity, as salmon played a major role in the Yokuts diet. The family was the primary political unit of the Northern Valley Yokuts. A village usually consisted of 300 people, made up of several related families. A headsman guided each tribe while living in the principal village (Wallace, 1978)

Historical Background

The history of the northern portion of the San Joaquin Valley is complex, with each region having distinct patterns of settlement and exploration. In 1772 Pedro Fages conducted the first exploration of the San Joaquin Valley. Historians credit Fages with the discovery of the San Joaquin River (he called it the Rio San Francisco). Lieutenant Gabriel Moraga conducted explorations of new mission sites in the interior in 1806, and again in 1808. He named all of the major tributaries of the San Joaquin River during these two explorations (Hoover et al, 1990; Beck and Williams, 1972).

In 1821, Mexico took control of California and began awarding large land grants to serve as a buffer between the raiding Indians and the coastal settlements. American control over California began in 1848 as part of the settlement of the Mexican War. The Gold Rush brought thousands of men into California looking for gold. After initial failures at mining, many of them moved down into the San Joaquin Valley and settled on portions of the Spanish and Mexican land grants. By the 1860's, agriculture had established itself in the San Joaquin Valley. Agricultural pursuits did not become widespread until the San Joaquin River and its tributaries underwent some alterations with levees and canals for irrigation and flood control (Beck and Haase, 1974; Beck and Williams, 1972; Hundley, 1992).

Methodology. Archival research was done to prepare the previous cultural overviews. A records check for known cultural resources was performed by the Central San Joaquin Valley Information Center at California State University, Bakersfield. In addition, the Corps conducted a records check at the Central California Information Center at California State College, Stanislaus. Site locations, site characteristics, and a count of previous archeological surveys were obtained or requested. The search area was limited to one-half mile on each side of the San Joaquin River from Mossdale to Friant Dam and each of the 14 identified diversion areas.

Information gathered from the Information Centers revealed that 70 archeological surveys have been completed in or near this Area of Potential Effect. The majority of these surveys were small, consisting of only a few acres. Inquiries to the Bureau of Reclamation and the California Department of Parks and Recreation revealed that each organization has completed surveys for refuge and park areas in or adjacent to the study area. The records check identified the locations of 78 prehistoric sites, 7 historic sites, and 9 ethnographic sites in or near the study area.

Environmental Impacts. Impacts to cultural resources are difficult to assess at this level of study. Some reaches of the San Joaquin River in the study area have undergone intensive ground surveys, but most have not. Virtually none of the diversion areas have been surveyed for cultural resources. An additional obstacle to impact analysis is the lack of specific information regarding each alternative. Based on available information, it is likely that some of the alternatives could affect significant cultural resources.

No Action. Description of the impacts for this alternative is designed to establish the without-project conditions for the study area. Certain cultural resources would be affected even without a flood-control project. Continuing urban expansion and agricultural practices could destroy many prehistoric and historic sites. Natural processes such as erosion, root and rodent intrusion, flooding, and grazing could affect prehistoric sites. Vandalism, through deliberate looting and collecting, is a national problem and is expected to continue.

Channel and Levee Modification. Four locations along the San Joaquin River are identified for structural repairs. Impacts to cultural resources could result from construction of berms, toe drains, access roads, and staging areas, and levee removal and reconstruction.

Additional impacts to cultural resources may result from vegetation and sediment removal. Because specific areas for these activities have not been finalized, the entire reach of the San Joaquin River from Mossdale to Friant Dam was examined during the records search. There are 37 known cultural resources site within one-half mile of the San Joaquin River, some of which could be affected by this alternative.

Full Diversion Areas. The literature search located a total of 35 cultural resource sites within or adjacent to the 14 temporary storage areas in this alternative. Most of these diversion areas have not been surveyed for cultural resources, so additional sites may exist.

Impacts to cultural resources from this alternative could result from inundation; construction of berms, dikes, drains, culvert structures, and associated staging areas; and procurement of borrow materials.

Partial Diversion Areas. This alternative contains 14 known cultural resources in 10 of the above-mentioned 14 temporary storage areas. Impacts to cultural resources would be similar to the Full Diversion Areas alternative.

Environmental Restoration with Flood Control. This alternative consists of four restoration projects in conjunction with five diversion areas identified in the Full Diversion Areas alternative. These are: Grasslands Water District, Arena Plains I and II, Area West of Eastside Canal, and China Island. There are three known cultural resources sites within or adjacent to this alternative. The majority of land affected by this alternative has never been surveyed for cultural resources.

Impacts in the diversion areas would be similar to the Full Diversion Areas alternative. Impacts to cultural resources from the restoration projects could result from inundation, construction of berms, dikes, canals, land contouring, and associated construction roads and staging areas. Planting of riparian vegetation could adversely affect cultural resources through disruption of the sites during soil preparation.

Mitigation. Mitigation of impacts to cultural resources would be accomplished under a Memorandum of Agreement between the Corps, local sponsor, State Historic Preservation Office (SHPO), and Advisory Council on Historic Preservation as required by Section 106 of the National Historic Preservation Act of 1966, as amended; 36 CFR 800; and ER 1105-2-100. Avoidance or preservation of significant cultural resources would be given foremost consideration when selecting project alternatives. Other mitigation measures could include data recovery through scientific excavation, archival research, recordation, relocation, and purchase of areas with comparable cultural resources.

FINDINGS AND ADDITIONAL STUDIES NEEDED

Based on a preliminary assessment of impacts expected to result from implementation of the flood control and environmental restoration alternatives, it will be necessary to prepare an environmental impact statement (EIS) during the feasibility phase of planning.

Future studies that are believed necessary to prepare an EIS and determine suitable mitigation depend on which alternatives are deemed feasible for future study. Additional studies needed are discussed below by subject category.

Fish and Wildlife and Endangered Species Studies. In accordance with the Fish and Wildlife Coordination Act, a Coordination Act Report prepared by the FWS will be required. Scopes of work for this report and any other needed coordination activities, and the funds to be transferred to complete these tasks, will be negotiated with FWS.

A Habitat Evaluation Procedure (HEP) will be needed to measure impacts to aquatic and terrestrial resources. This study will quantify habitat losses due to the selected alternatives as compared to existing habitat values. It would also quantify habitat values of alternative mitigation areas. An incremental analysis of mitigation would be performed in conjunction with the HEP.

A biological data report on endangered species found in the project area of the selected alternatives will be needed in order to prepare a biological assessment as required under Section 7 of the Endangered Species Act. The assessment will evaluate potential impacts to endangered species and conclude if adverse impacts are likely. A biological opinion will be requested from FWS in accordance with Section 7. Formal consultation will be needed if adverse impacts are likely.

In a Planning Aid Letter of October 6, 1992 (Attachment 1), the FWS recommended the following additional studies. The selection of these studies is dependent on the alternatives that are evaluated in the feasibility phase.

1. Field surveys to determine sensitive habitat areas for species of special concern, such as Swainson's hawk, within all proposed project areas, to include information on presence of species, nesting areas, territories, etc.

2. An inventory of the extent of Shaded Riverine Aquatic Cover along the San Joaquin River and its major tributaries to establish baseline conditions.

In addition, it may be necessary to inventory the extent and condition of riparian habitat along the San Joaquin River and its major tributaries.

Hydrological and Water Quality Studies. Additional water quality analyses and analysis of project impacts on water quality would be performed, including a 404 (b)(1) analysis. A jurisdictional wetlands survey would be done to assist in determining the impacts of project alternatives on wetlands. A new hydrological study of the San Joaquin River system is needed in order to adequately evaluate potential impacts from altered flows.

Soils and Topographic Studies. Soil surveys may be needed to document and/or verify the chemical and physical characteristics of the soils in the diversion storage and restoration areas. Topographic surveys should also be completed to verify USGS elevational data and in light of possible ground subsidence. Both of these surveys would help to evaluate the appropriateness and locations of engineering features (i.e., water control/ diversion structures, cross levees, new wetland basins, etc.).

Cultural Resources Studies. To comply with the Section 106 review process, 36 CFR 800, ER 1105-2-100, and other Federal laws or regulations, the Corps must make a reasonable and good faith

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effort to identify historic properties that may be affected by its undertaking and gather sufficient information to evaluate the eligibility of these properties for the National Register of Historic Places. Should the project proceed to the feasibility phase of planning, then additional field, scientific, and/or archival studies would be completed. Any sites within the area of potential project effect must be evaluated against criteria established for listing on the National Register of Historic Places. Based on this finding, concurrence of eligibility and a determination of effect will be made in consultation with the SHPO. Sites will be evaluated for the National Register of Historic Places and effects assessed in conjunction with preparation of an environmental impact statement during the feasibility phase.

Public Participation. A public participation program would be developed to include activities needed to communicate with the public about environmental issues and potential impacts.

NEPA Activities. Preparation, coordination and obtaining input on all required environmental information would be accomplished.

Environmental Input to Plan Formulation. This would be included in the study process to assist in formulating a selected plan.

LIST OF PREPARERS AND REVIEWERS

Name Discipline/ Expertise	Experience	Task Completed
Thomas Bonetti Environmental Planner	1 yr environmental planning, Corps; 1 yr recreation planning, State of California	Preparation of Recreation Section
Dorothy Cornell Technical Writer	22 yrs, Corps	Report review
Elizabeth Davis Sociologist	7 yrs environmental planning, Corps	Preparation of Land Use and Socio-economic Sec
Jerry Fuentes Social Scientist/ Historian	2 yrs environmental planning, Corps	Preparation of Cultural Res Section
Robert Koenigs General Biologist/ Environmental Planner	8 yrs environmental planning, Corps; 12 yrs State and private natural resource research/mgmt	Report review
Gregory Mitchell Eco-Geographer/ Ecology and Natural Resource Mgmt.	2 yrs environmental planning, Corps; 2 yrs research projects, various State and Federal agencies	Preparation of main report
Sannie Osborn Archeologist/ Environmental Planner	10 yrs cultural res mgmt, Corps; 6 yrs museum curator	Report review
Lynne Stevenson Technical Writer/ Water Res Planner	7 yrs planning studies, Corps; 10 yrs professional librarian	Review and editing

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ATTACHMENT 1

FWS PLANNING AID LETTER